Power Engineering

APRIL 1961

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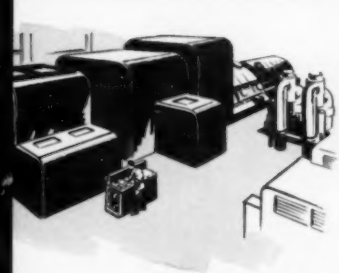

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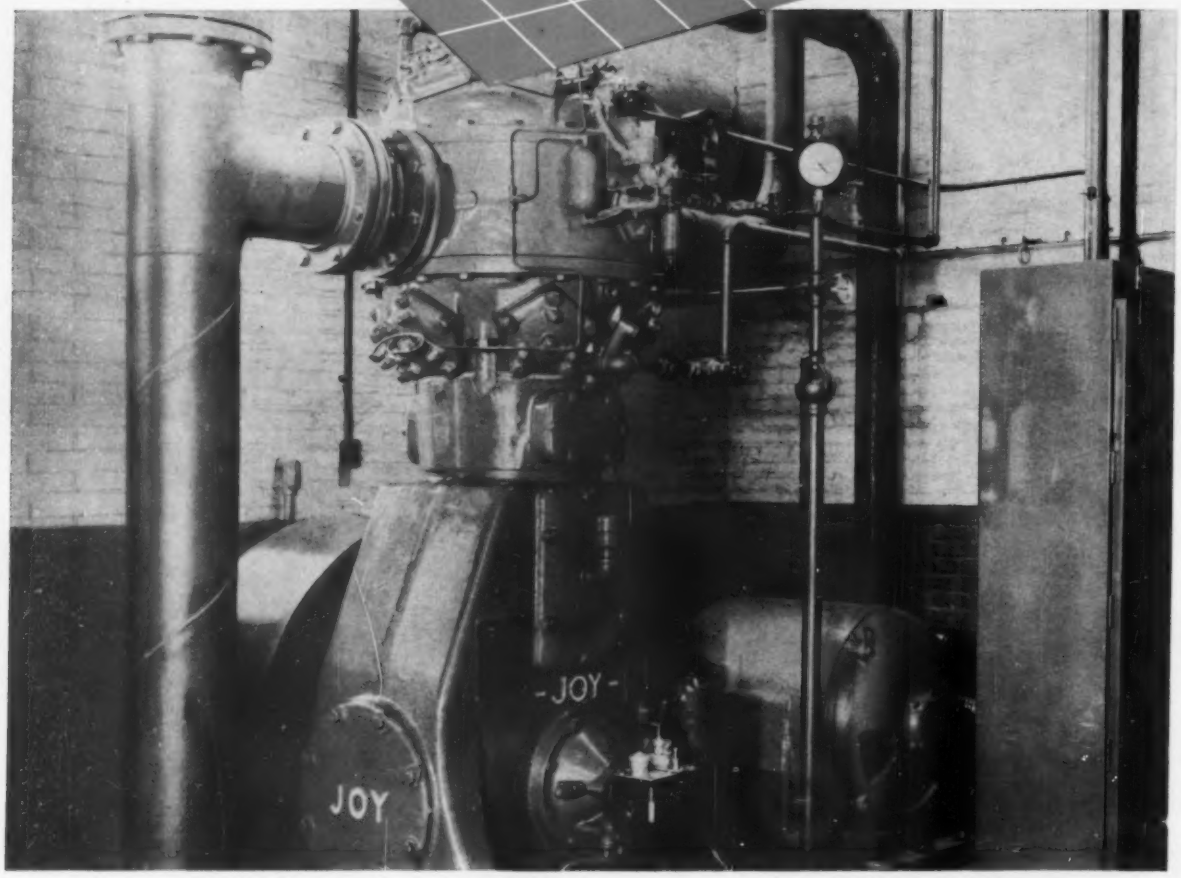

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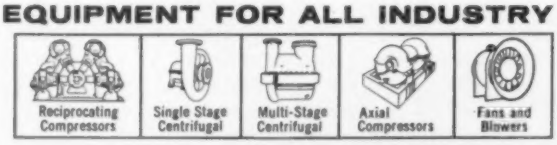

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BPA ABP NBP

THE RECESSION WASN'T TOO BAD

Long before it actually started, the smart economists predicted the "recession of '60." Reluctantly, all admitted it was a reality—after making a noble attempt to whitewash the whole affair.

Sure, there has been a recession, and we'll always have them—as long as the law of supply and demand continues to be a basic rule of existence. Now we have begun to see the end of the downward trend, at least in the power industry, and we're on the upward part of the business curve again.

Proof of this lies in the news that's coming from utility and industrial companies—all over the country. After a lull in the normal pattern of expansion, utilities are once again on the go! At this time, predictions on power field expansion run to about $5 billion for 1961.

If the power industry is again spending money for expansion, it is to adequately serve an ever-increasing demand for power. Also, it follows that if more power is needed, more construction is also required; or vice versa. In either case, the power field is starting to boom again. So, let's quit talking about how bad business is—and think about the brighter side for a change.

Bob McCaw
EDITOR

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Engineers' Preview

OF NEWS AND COMING EVENTS IN THE POWER FIELD

FRAMEWORK of the new power policy of the U.S. Department of the Interior came Feb 14, when Secretary Udall announced a broad program built on five foundation stones. These are:

1. Federal dams shall where feasible include facilities for generating electrical energy. 2. Preference in power sales shall be given to public agencies and coöperatives. 3. Power disposal shall be for the particular benefit of domestic and rural consumers. 4. Power shall be sold at the lowest possible rates consistent with sound business principles. 5. Power disposal shall be such as to encourage widespread use and to prevent monopolization.

GOULD-NATIONAL BATTERIES has signed a contract with the Pure Oil Co for a joint research program on fuel cells and fuels. The program will be under the direction of Dr. Royce E. Biddick, a member of the Gould-National research staff.

TAMPA ELECTRIC CO's Gannon power station has a new 175,000-kw generating unit, the largest of three now in operation at the plant. Largest coal-fired station in Florida, Gannon consumes an average of 2600 tons daily. A fourth generating unit, of 190,000 kw, has been ordered and is scheduled to be in operation in 1963.

LAKE BOATS bringing coal to what will be Canada's largest steam-electric power plant will unload at a cellular dock jutting 1600 feet out into Lake Ontario. Just completed by Dravo of Canada Limited, Toronto, the dock will serve the new $250-million Ontario Hydro Lakeview Generating Station, scheduled to go into service this year. The new station, located about 10 miles southwest of downtown Toronto, will have an ultimate generating capacity of 1,800,000 kw.

CONSUMERS POWER CO of Jackson, Mich., has obtained options to purchase several hundred acres on Lake Michigan about three miles south of Ludington as the future site of a hydroelectric development which would include a generating plant with an artificial lake or reservoir.

Using the pumped-storage principle, reversible turbines actuated by electricity generated elsewhere on the Consumers system would pump water from Lake Michigan into the artificial lake above the plant during certain hours. At other hours the water would flow down through the turbines into Lake Michigan, generating electricity on the way.

The land to be acquired by Consumers is about 300 feet above the Lake Michigan level.

PROCUREMENT contracts for Bureau of Reclamation supplies and equipment have been moved up as much as two years in expedited operations undertaken since February 9, Secretary of the Interior Stewart L. Udall reports.

Invitations to bid have gone out on 2,662,000 feet of aluminum cable, 1,775,000 feet of steel strand cable and 33,200 insulators, as well as related hardware which will be used in the Colorado River Storage Project transmission grid.

Nordberg Mfg Co of Milwaukee, which underbid its closest rival, a foreign firm, has been awarded two Bureau of Reclamation contracts totaling $751,500 for six butterfly valves for three hydroelectric plants now being constructed for the Trinity River Division of California's Central Valley Project.

Bid calls for the manufacture and site installation of eight 112,500-kw generators for Glen Canyon power plant on the Colorado River in Arizona have been announced by the Department. The power plant will be the third largest in a Bureau of Reclamation multipurpose dam, exceeded only by those at Grand Coulee and Hoover Dams. The 900,000-kw plant is now under construction at the toe of the 710-ft-high concrete-arch Glen Canyon Dam on the Colorado River near the Arizona-Utah State line.

WEST PENN POWER CO has ordered a 250,000-kw turbine generator from Westinghouse. The unit will be installed in the utility's Mitchell Station at Courtney, near Monongahela, Pa. It is expected to be completed and in operation late in 1963. The unit will be a tandem-compound, quadruple-flow turbine featuring a hydrogen inner-cooled generator. It will more than double the capability of Mitchell Station, which presently has two generators totaling 174,000 kw.

ALLIS-CHALMERS has been awarded a contract to build four large hydraulic turbines for Susquehanna Power Co, a subsidiary of Philadelphia Electric Co, subject to the approval of the Federal Power Commission.

Four vertical fixed-blade propeller-type hydraulic turbines will be in-

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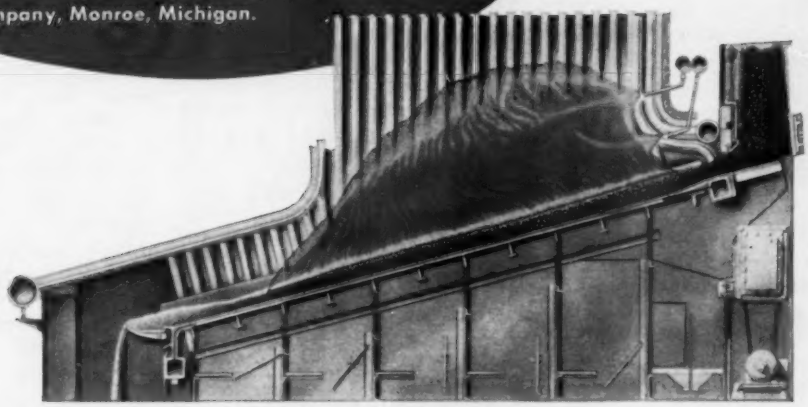
Vibra-Grate and Taylor Multiple Retort Stokers formerly manufactured by American Engineering Company of Philadelphia are now and will continue to be manufactured, sold and serviced by Detroit Stoker Company, Monroe, Michigan.



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stalled in the power company's Conowingo hydroelectric station located on the Susquehanna River in Maryland. Scheduled for operation some time in 1965, the new turbines will about double the present 252,000-kw rating of the plant.

A-C is also furnishing two 150-mva transformers, the auxiliary switchgear and nearly all the miscellaneous pumps for Kentucky Power Co's new Big Sandy Plant near Louisa, Ky.

NIAGARA POWER PROJECT, the western world's largest power project, with a capacity of 2,190,000 kilowatts, on Feb 10 was the scene of a colorful first-power ceremony by New York State Power Authority. Just three years from the start of construction, the first of the project's 13 waterwheel generators made by Westinghouse, with a rating of 150,000 kw each, began producing power.

DURING 1961, Central Illinois Public Service Co will spend about $13 million for new construction and replacement facilities. This will bring expenditures of the company on construction and expansion programs to about $238 million since World War II. CIPS now serves 520 communities in central and southern Illinois with electricity and 23 with gas.

BABCOCK & WILCOX CO reports a net income for 1960 of $17,818,000, or $2.88 per share, on shipments of $310,999,000. This income is 12 per cent higher than that for 1959 and is the highest in the company's history.

A SHARP UPTURN in fabricated structural steel sales was registered in January, according to reports compiled by the American Institute of Steel Construction. January bookings totaled 272,177 tons, a jump of 22 per cent over the previous month and some 50,000 tons greater than the corresponding January a year ago.

VIRGINIA ELECTRIC AND POWER CO recently approved a 1961 construction budget of $85 million — largest in the company's 52-year history. Major expense items this year include $23 million on the company's 200,000-kw hydroelectric power station now under construction on the Roanoke River in North Carolina, and $57,823,000 for other generating facilities.

COMBUSTION ENGINEERING, Chattanooga, has been awarded a contract by TVA for the boiler of one of the two 800-Mw steam turbine generators now on order. The contract includes an option for another boiler for the second unit. The boilers will deliver 6,100,000 pounds of steam per hour at 2400 psi 1050 F. Contract price is $17,440,000 for one boiler and $34,660,000 for two.

At the same time TVA has announced that it has accepted an alternative design offered by General Electric for the two turbine generators. The change will increase the guaranteed gross capability of the units by 35,000 kw to 900,000 kw each, and will add $1 million to the cost of each unit, bringing the total cost for the two to $32,764,000.

First of the two units is scheduled for operation by September 1964, and the second a year later. Location of the units has not been determined.

INDUSTRIAL ELECTRIFICATION COUNCIL has released its Industrial Power Distribution Course for sale to electric utilities, electric leagues and to other groups which may be organized to put it on. Designed for presentation in ten 2½-hour demonstration-type lectures, the course's main purpose is to educate industrial plant personnel on the need for, and the advantages of, good electrical distribution.

The course was developed and field-tested by West Penn Power Co, and is sold in the form of a kit. Cost of the complete kit is $400 f.o.b., 750 Third Ave, New York 17, N. Y.

ENGINEERS' SALARY LEVELS rose approximately 5 per cent per year between 1958 and 1960 according to a survey conducted by the Engineering Manpower Commission of Engineers Joint Council. The over-all median annual salary now stands at $9600. The report covers about a quarter of the engineering force of the United States.

YANKEE ATOMIC ELECTRIC CO's atomic power plant in Rowe, Mass., has successfully completed a 500-hour test period of operations. This test run at full licensed power of 110 Mw marked the final phase of the plant's start-up testing program. Since November 10, 1960, when the plant began to produce electric power, nearly 1,000,000 kwh of power has gone into the interconnected transmission lines of the 10 investor-owned New England utilities who built the station.

MEETINGS: Southeastern Electric Exchange's Engineering and Operation Section meets for its spring session April 13–14 at the Hollywood Beach Hotel, Hollywood, Fla.

12th annual Rural Electric Generating Coöperatives Conference will be held in Mobile, Ala., May 1–4, at the Battle House Hotel.

Among the subjects to be presented are the following: steam turbine design, Z. Stanley Stys, Brown Boveri; cooling towers, Roy W. Maze, The Marley Co; new excitation system, J. A. Zimmerman, Allis-Chalmers; exciter and generator maintenance, G. L. Oscaron, Electrical Machinery Mfg Co; fluid drive in power plant operations, R. D. O'Neil, American Standard Products; jacket water coolers, lube oil coolers and intercoolers, H. J. Resag, Young Radiator Co.

John H. Warren of Republic Flow Meters speaks on electronic combustion controls; Robert F. Haller of Babcock & Wilcox, on natural circulation drum boilers; Jack E. Cox, of Manning, Maxwell & Moore, on safety valves; Bobby L. Green, of The Air Preheater Corp, on air preheaters; R. J. Carpenter of General Electric, on combined cycle of gas turbine and steam turbine.

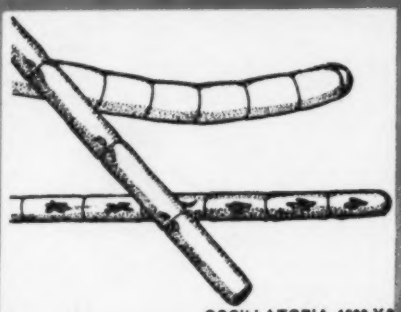
29th annual convention of the Edison Electric Institute is set for June 5–7, Waldorf-Astoria, New York City.

National Electrical Manufacturers Assn will hold its first western conference at the Biltmore Hotel in Los Angeles, June 8–9.

National Society of Professional Engineers will hold its 27th annual meeting July 4–7 at the Olympic Hotel in Seattle, Washington.

Fifth annual Air Pollution Control Assn meeting is scheduled for June 11–15 at the Hotel Commodore in New York City. There will be 18 sessions, also an exhibit.

Here's what grows in your cooling towers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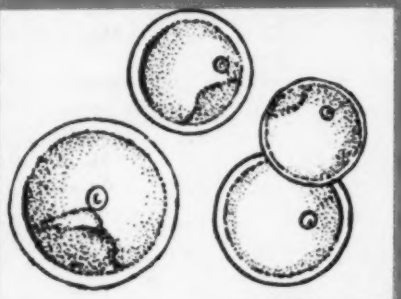
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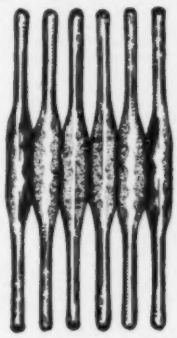
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Tracers

COMMENT, OPINION, AND NEWS ABOUT PEOPLE

▶ **William S. Ginn,** G-E vice-president and general manager of the company's Turbine Div, is emphasizing two factors in his division's effort to improve business. These are: 1. penetration of overseas markets, and 2. persuading American utilities to accept early shipment of orders.

> In Feb, the turbine division's efforts to meet competition and secure foreign business paid its first reward. An order was received from Taiwan for a 140,000-kw turbine generator. We also have submitted bids for three other foreign units, each a 350,000-kw machine.
>
> On domestic business, I've been trying to show the nation's electric utility executives how they could save more than a quarter of a billion dollars over the next ten years by placing their orders for steam turbine generators on a regular, rather than a cyclical basis.

One major utility to take advantage of G-E's incentive of a reduced price for early shipment was the Tennessee Valley Authority, in its order for two 800,000-kw units, which will be the world's largest powermakers ever built (see POWER ENGINEERING, Feb, page 46).

By accepting shipment in advance of its need dates, TVA saved a reported $3,200,000. This allowed G-E to bring work into its turbine-generator factory "when it would be needed the most."

▶ **C. G. Crawford,** manager of Baldwin-Lima-Hamilton Corp's hydraulic turbine sales and service, writes:

> Your December issue has beginning on page 82 an article entitled, Grand Coulee Pumping Plant Operation and Maintenance, and I would very much like to get 15 copies of this article. This article in effect brings up to date the paper which Glenn R. Barker, Jr delivered at the American Power Conference in Chicago in March, 1958.
>
> The Grand Coulee pumps are of considerable personal interest to me as well as to our company as they were manufactured under a joint venture contract with the contractor's name, The Pelton Water Wheel Co and Byron Jackson Co. I personally handled the preparation and presentation of the bid and the administration of the contract.

▶ **Labon Backer,** chief of the Bureau of Reclamation's power division, region 5, writes us:

> You and your organization are doing a "terrific" job with your publication. It is far and away the best in its field and it seems to get better every month. Your coverage of new developments is excellent — I think you usually beat all the others in this respect. The style of the editorial content is concise, clear and to the point, and it "reads" well.

▶ **Norman Clapp** of Wisconsin has been appointed REA administrator, succeeding David Hamil. An assistant to former senator Robert M. LaFollete, Clapp was active in the creation and development of REA in its early days.

Stewart L. Udall, the new Secretary of the Interior, will have **James K. Carr** as Under Secretary. Carr was formerly assistant general manager of the Sacramento, Cal., Municipal Utility District, and chairman of the California Water Commission. **Ken Holum** is the new Assistant Secretary for Water and Power. Before his appointment he was executive director of the Mid-West Electric Consumers Assn of Aberdeen, S.D. **Floyd E. Dominy** continues as Commissioner of Reclamation. **Joseph C. Swidler,** attorney from Nashville, Tenn., has been named chairman of the Federal Power Commission.

Arthur W. Pugsley, president of North American Mogul Products Co since 1951, has been named chairman of the board. C. Carlisle Tippit, now vice-president and treasurer, will become the new president and treasurer of the company.

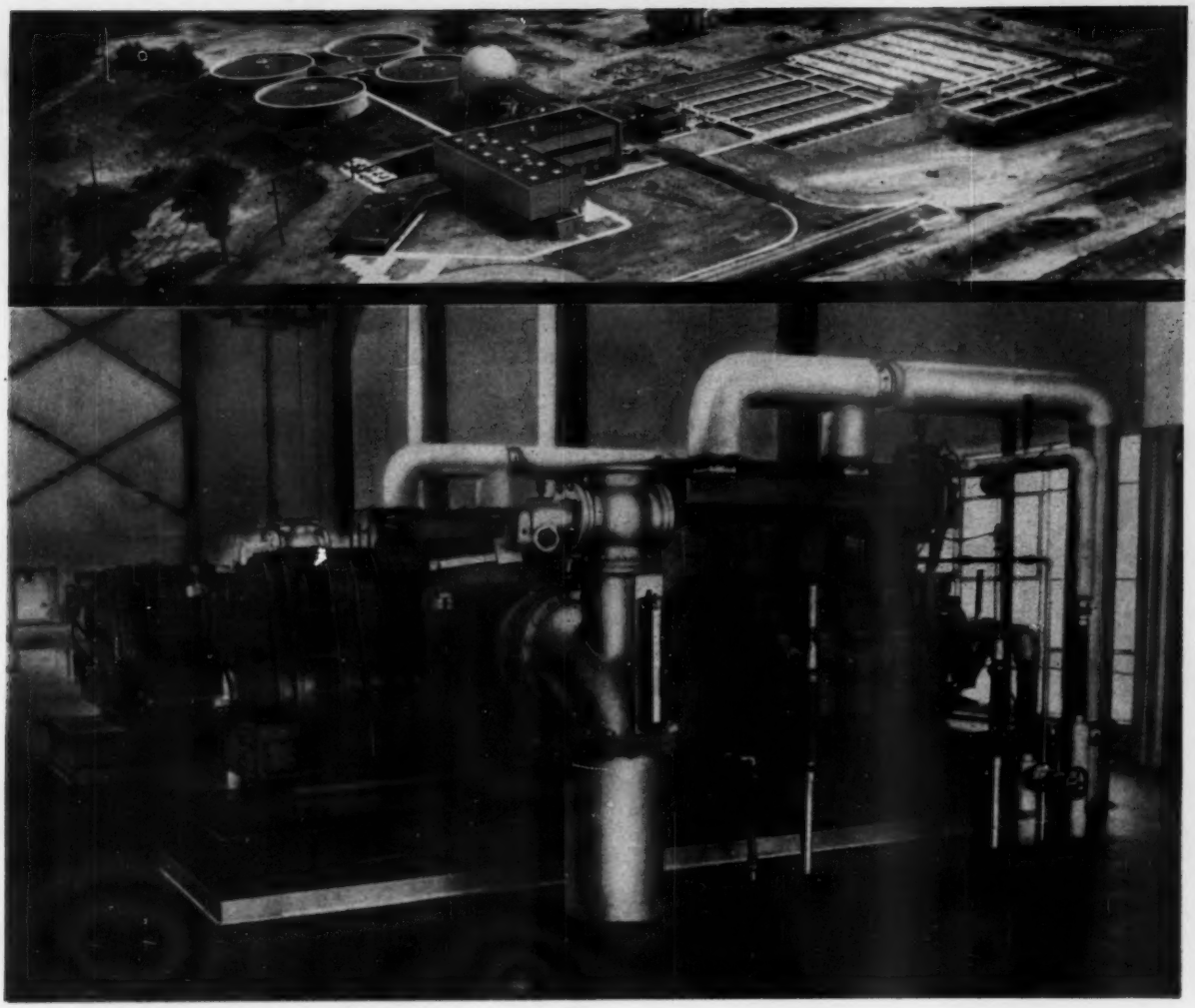
George E. Watkins has been appointed director of the new Research Division of Edison Electric Institute. Watkins has been associated with EEI since 1951. Seven leading electric company chief executives will guide the new division. Chairman is **Willis Gale,** chairman of the board, Commonwealth Edison Co. The other members are **Donald C. Luce,** Public Service Electric and Gas Co; **P. A. Fleger,** Duquesne Light Co; **R. A. Gibson,** Hartford Electric Light Co; **J. K. Hortor,** So. California Edison Co; **W. W. Lynch,** Texas Power and Light Co; and **W. O. Turner,** Louisiana Power and Light Co. The Research Division will involve projects suited to action by the industry as a whole.

Fred J. Robinson has been named service manager for American-Standard Industrial Div. He joined American-Standard in 1953, has served as divisional service supervisor since 1959.

Harold P. King, of King, Benioff and Associates, consulting firm of Sherman Oaks, Cal., has been elected president of the Consulting Engineers Council.

Francis B. Slichter, since 1949 chief of the Engineering Division, Civil Works, in the Office of the Chief of Army Engineers, retired March 10. Slichter, currently vice-president of the U.S. Committee of International Commission of Large Dams, is establishing practice as a consulting engineer from his home at Box Hill Farm, Burke, Virginia.

He was educated as a civil engineer at the University of Kansas City, Missouri, and the University of Kansas. He joined the Army Engineers at the Kansas City district in 1928 and worked on the Missouri River Basin Plan and was active in the construction and design of the Fort Peck Dam on the Missouri River.



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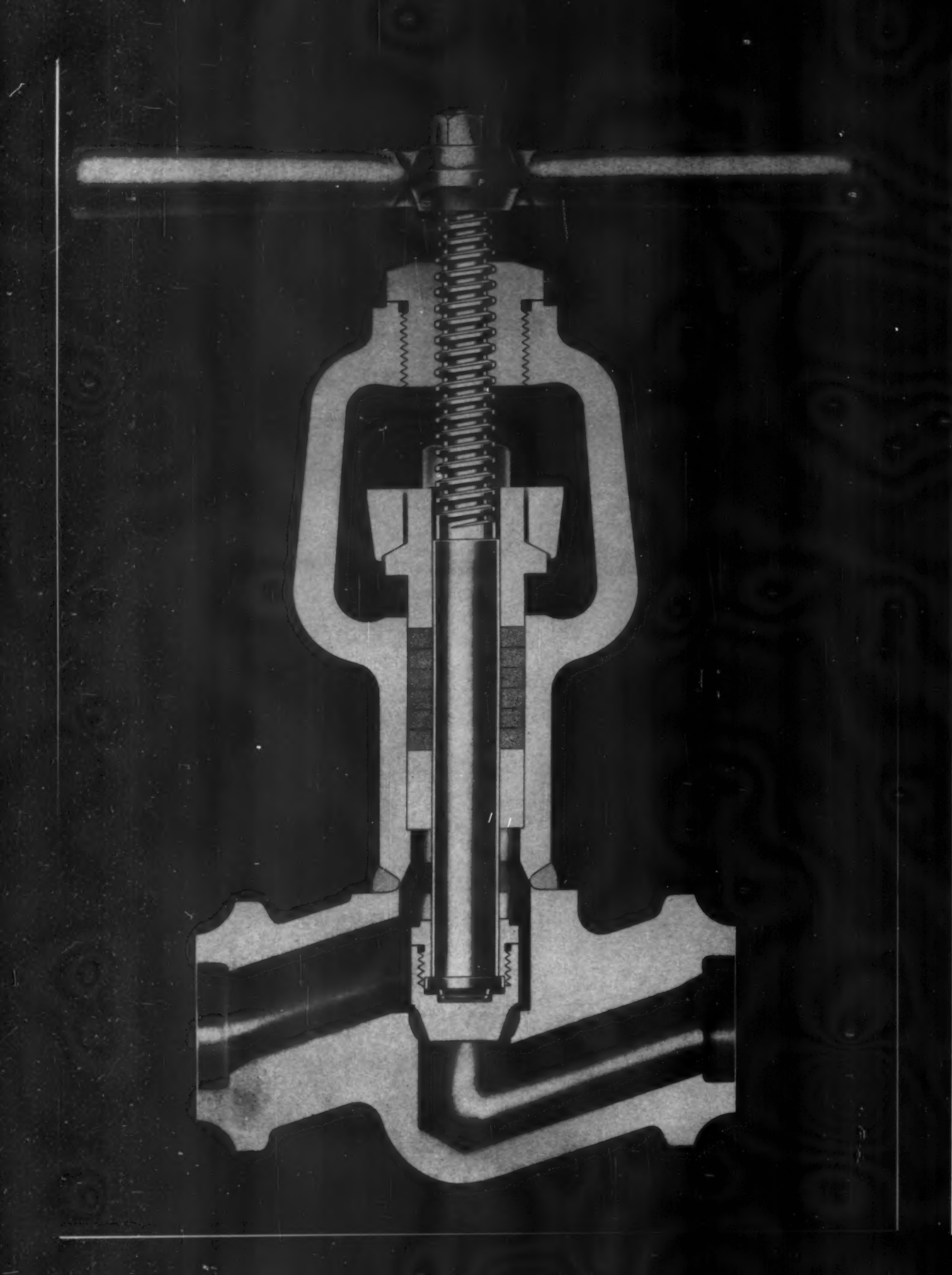

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The valve illustrated at the left is the Hancock Type 7130 Steel Globe Valve widely used by the power and process industries.

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Hoffman F & T Traps give quiet, continuous drainage. For quick access and ease of servicing and repair, all working parts are attached to removable cover . . . no need to break pipe connections.

600 SERIES INVERTED BUCKET TRAPS

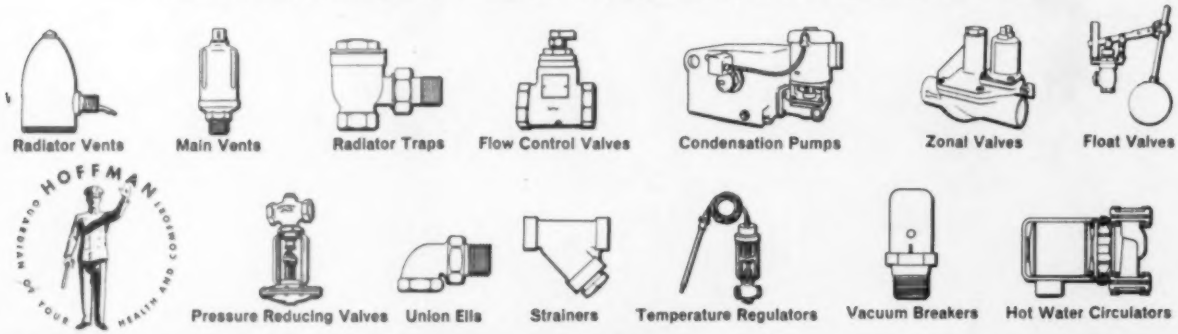
Hoffman Bucket Traps drain intermittently. Featuring stainless steel interiors and straight-through pipe connections. Available with various sized pins and seats for a wide range of pressures.

TRAPS

drain condensate and air from steam lines and equipment

Get maximum efficiency from your equipment and steam lines! Hoffman Traps are precisely engineered to drain condensate and air into return lines. Thus, active steam can continue to circulate and work effectively . . . steam lines and equipment can operate at peak efficiency. Traps shown are just two of the Hoffman Complete Line of quality-tested Steam Traps . . . low, medium and high pressure Thermostatic Traps, Float and Thermostatic Traps, and Inverted Bucket Traps.

HOFFMAN COMPLETE LINE OF SPECIALTIES...STEAM AND WATER



HOFFMAN SPECIALTY MFG. CORP. 1700 W. 10th STREET, INDIANAPOLIS 7, INDIANA

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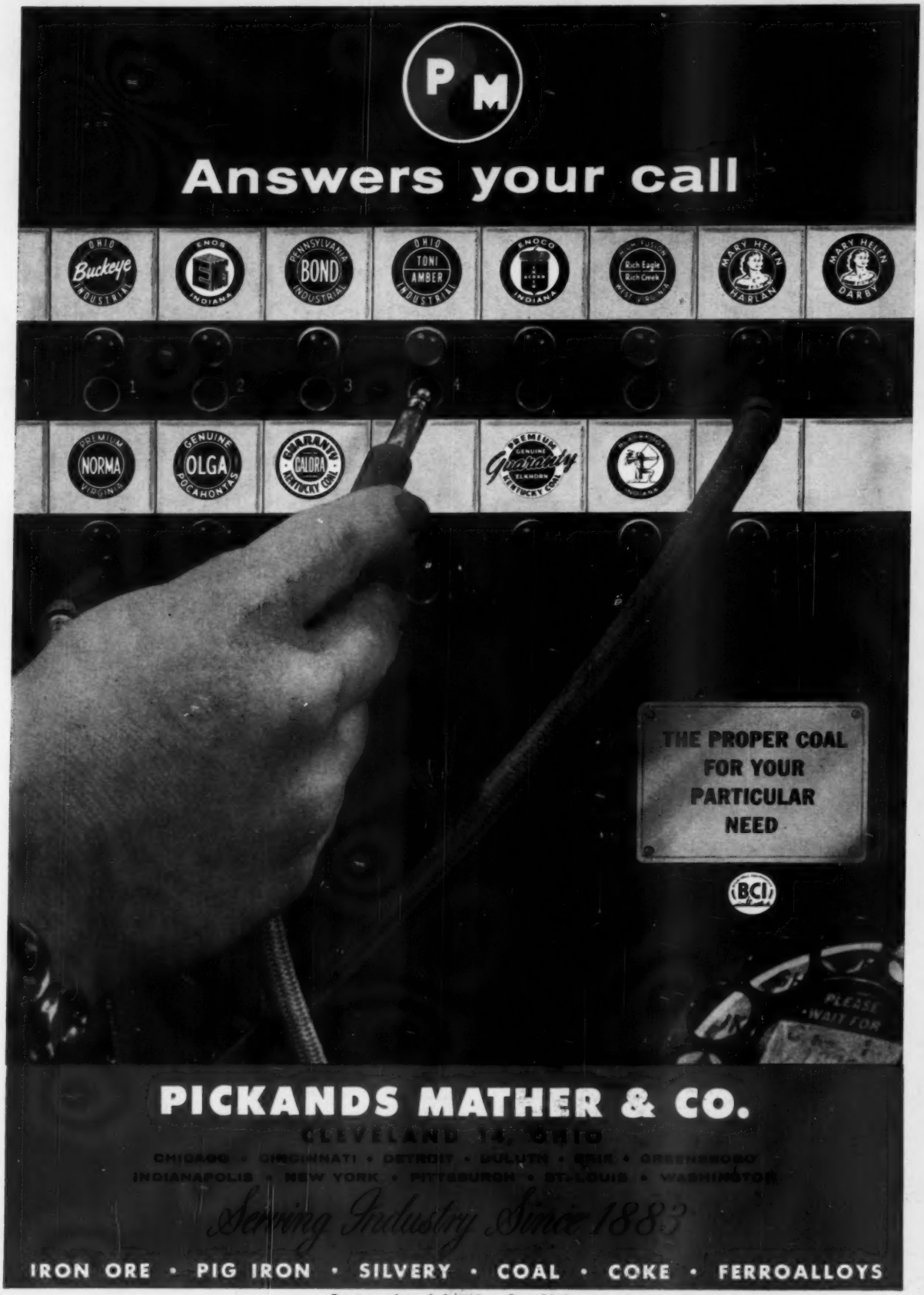

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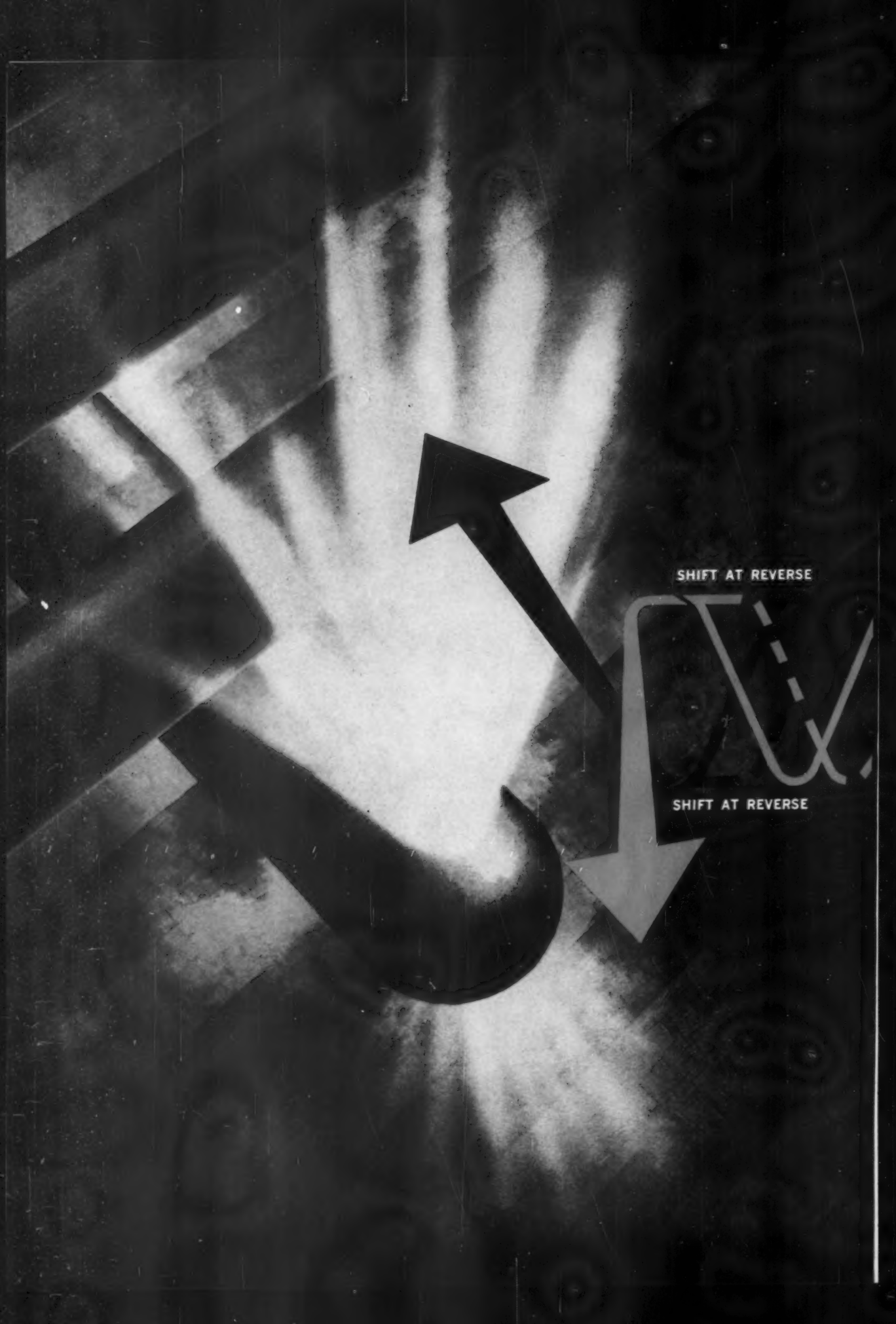
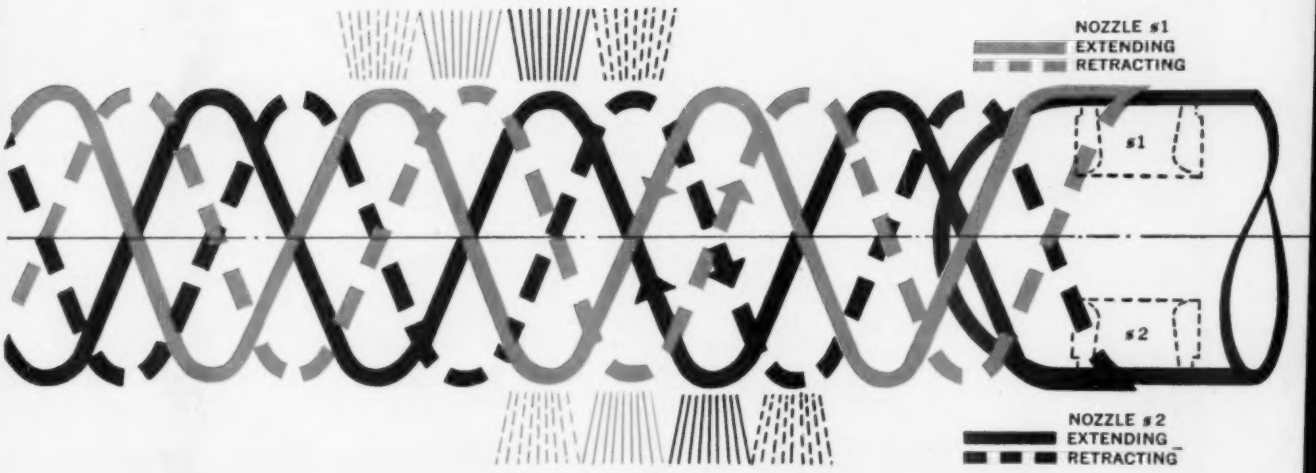

SHIFT AT REVERSE
SHIFT AT REVERSE

Diamond developed for more economical power...

A CLEAN SWEEP...EVERY INCH OF THE WAY

Get uniform, complete cleaning in those "tough-to-clean" zones. Specify Diamond's IK-300 Retractable Blower. The exclusive close-spaced IK helix assures a penetrating nozzle sweep every inch of travel regardless of tube bank arrangement and tube spacing. What's more, because sectionalized lance tube construction cuts deflection to a minimum, smaller boiler cavities are possible. In addition, a unique method of equalizing nozzle end-thrust assures "minimum-wobble" travel regardless of distance.

IK's are just part of the reason behind Diamond's established superiority in boiler cleaning systems. Add a complete line of cleaning equipment, an experienced, imaginative engineering staff and an unmatched service organization. No wonder thousands of utility and industrial power plants are equipped with Diamond Cleaning Systems — engineered and designed to provide you with more economical power.



Diamond

DIAMOND POWER SPECIALTY CORPORATION, Lancaster, Ohio • **DIAMOND SPECIALTY LIMITED,** Windsor, Ontario

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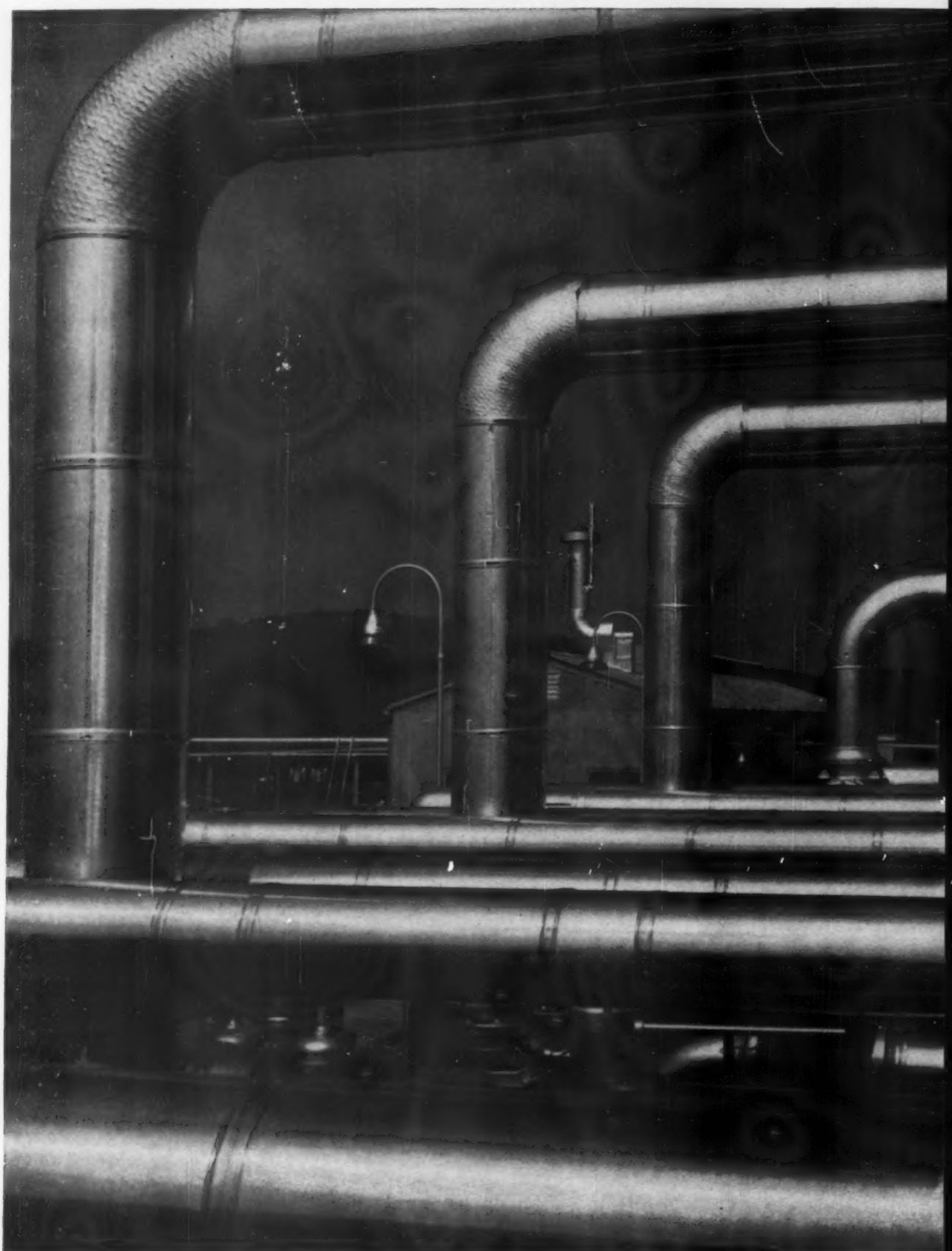
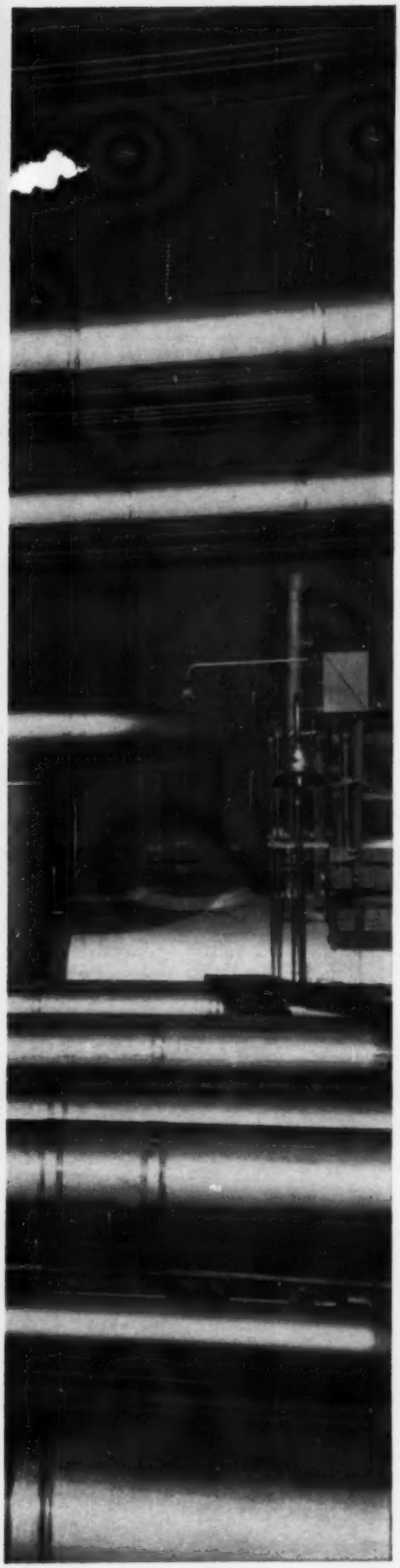


PHOTOGRAPHED AT NEW YORK STATE NATURAL GAS CORPORATION'S LEIDY COMPRESSOR STATION, TAMARACK, PA.



Installation time at Leidy Station cut 25% with prejacketed J-M METAL-ON® pipe insulation!

"ALMOST 2 MILES OF METAL-ON PROTECTS OUR OUTDOOR PIPELINES. THIS IS THE BEST—AND BEST-LOOKING—INSULATING JOB I'VE EVER SEEN,"
says head station engineer VICTOR CUMMINGS

Leidy Pool, with an ultimate storage capacity of 105.6-billion cubic feet of natural gas, is served by a compressor station incorporating almost two miles of outdoor pipelines. Both lines and equipment must be completely protected against northern Pennsylvania's violent winter storms, torrential spring rains and summer heat. Metal-On jacketing, developed by J-M, was chosen to handle this difficult job.

Metal-On is prefabricated at the factory in 36-inch lengths. Each length combines high-temperature J-M Thermobestos insulation . . . a moisture barrier . . . and a special aluminum alloy jacket. And because each length can be applied in one simple operation, erection time savings at Leidy averaged 25%! Metal-On can also be easily cut on the job with portable power or hand saws. Cutouts for hangers and supports are simple to make.

Maintenance savings can be very impressive, too. Metal-On doesn't corrode, needs no painting. The rugged jacketing, combined with a locking device that snaps closed and seals joints, will lock out weather and moisture permanently. And each section can be easily removed for trouble-shooting.

You may not have *two miles* of pipeline . . . but if you have a tough outdoor insulation problem, it will pay you to investigate J-M Metal-On. Just write to Johns-Manville, Box 14, New York 16, N. Y. In Canada: Port Credit, Ontario.

METAL-ON:
JUST MINUTES FROM CARTON TO PIPE!

JOHNS-MANVILLE

AN INSULATION FOR EVERY COMMERCIAL AND INDUSTRIAL USE

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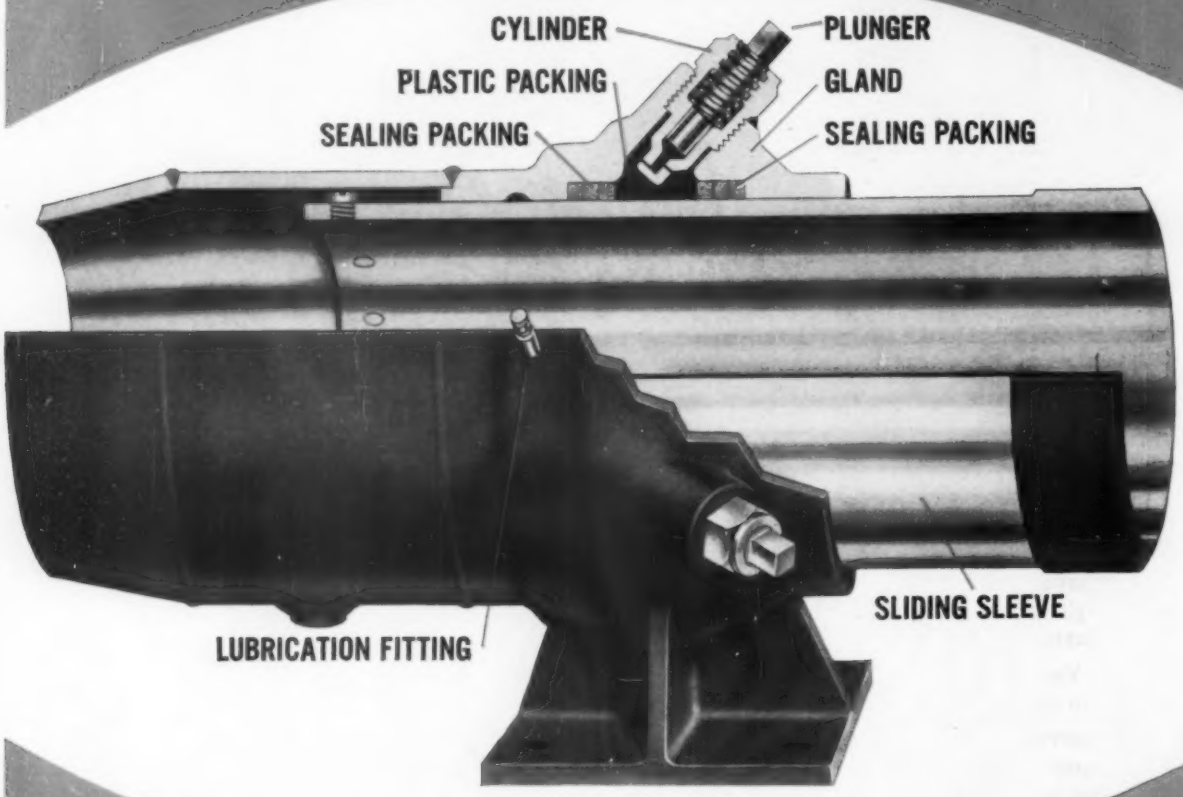
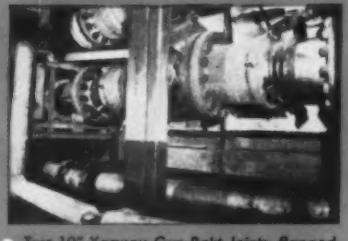


Only Yarway GUN-PAKT combines these outstanding features with design simplicity. GUN-PAKT Joints are available in single or double ends, welding or flanged, and in standard pipe sizes up to 30".

5 of 36 Yarway Gun-Pakt Joints, 2½" to 16" sizes, welding ends on steam lines at mid-west state institution.

6" Yarway Gun-Pakt Joint, flanged ends, on steam line at eastern industrial plant.



Two 10" Yarway Gun-Pakt Joints, flanged ends, on return line of high temperature water system at New Jersey industrial plant.

Group of 8" Yarway Gun-Pakt Joints, with automatic lubrication, on high temperature water lines at large international airport.

WATER LINES THESE BENEFITS...

- ✓ *TROUBLE-FREE SERVICE*
- ✓ *LOW MAINTENANCE*
- ✓ *SIMPLIFIED DESIGN*

WITH YARWAY GUN-PAKT EXPANSION JOINTS

Only Yarway GUN-PAKT Expansion Joints offer *simplicity*, *efficiency*, and *freedom from the "headaches"* that plague many plant engineers. That's why more engineers are specifying Yarway for efficient operation of steam and high temperature water piping in industrial plants, institutions and universities.

Yarway GUN-PAKT Expansion Joints offer you these advantages:

CONTINUOUS SERVICE—Shutdowns are eliminated. Addition of packing is seldom necessary, but may be added *under full line pressure.* No vents. Never needs repacking. *One plant lost, through forced shutdowns, production valued at $25,000. a day—until joints were replaced with Yarway* GUN-PAKT.

RUGGED DEPENDABILITY — All-steel construction with durable, chromium-plated, seamless steel sleeves. No chance of *metal fatigue.* Wrought steel bases provide rugged, positive anchorage.

INTERNAL AND EXTERNAL GUIDES—Positive alignment of sleeve in stuffing box—*where it counts.*

LIGHT WEIGHT, STREAMLINED DESIGN—Requires less space to install, less space to maintain, smaller manholes, fewer joints needed per length of pipeline.

MINIMUM MAINTENANCE—Many GUN-PAKT Joints have been *in service over 25 years with only nominal maintenance*—no major repairs or periodic overhauls. NEVER A SHUTDOWN FOR REPACKING. Maintenance records show an average of one manhour and 65 cents worth of packing needed per joint per year.

Why don't *you* investigate the advantages of GUN-PAKT Joints now? A Yarway engineer will be glad to discuss the subject with you. Invite him to call. Ask for Yarway Bulletin EJ-1917, too.

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YARWAY

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Some Straight Talk On Steam Trap Capacity

...or pulling away the curtain of confusion that surrounds steam trap capacity ratings.

Unfortunately, for the steam trap buyer, the subject of steam trap capacity has become cloudy and confused by a landslide of claims, counterclaims and inconsistent "standards" for measurement. So let's take a cold hard look at this subject so vital to the efficient operation of your plant.

What Determines Steam Trap Capacity?

There are three factors that determine the capacity of a steam trap:

1. The area of the orifice.
2. The density of the condensate.
3. The pressure differential across the trap.

Let's take a closer look at each of these:

Area of orifice is usually specified by the trap manufacturer or can be calculated from the diameter. Nothing complicated here.

Density of condensate depends on temperature. A cubic foot of cold water weighs 62.4 lbs. At 250° F. or 15 psi, it weighs less than 59 lbs. This is important. Don't overlook it.

Pressure differential across the trap is most significant. And it is complicated by the many factors that affect it, such as:

1. Pressure drop between unit drained and the trap when the trap valve is open.

2. Distance the trap valve is moved from the valve seat.

3. Back pressure on the trap with orifice closed; i.e., return header pressure.

4. Increase in back pressure produced by condensate and flash steam flowing in the discharge line. This in turn is affected by the diameter and length of the discharge line, plus friction caused by valves and fittings.

Orifice Capacity Vs. Steam Trap Capacity

Figure 1 shows a ½" diameter sharp-edged orifice at the end of a pipe filled with cold water at 15 lbs. pressure. The capacity of this orifice, using a .61 coefficient of flow would be 8,800 lbs. per hr. Now, would this ½" orifice if used in a ¾" steam trap installed as shown in Figure 2 provide the trap with a continuous discharge capacity of 8,800 lbs. of hot condensate per hour? The answer is "no". And here are some of the reasons why:

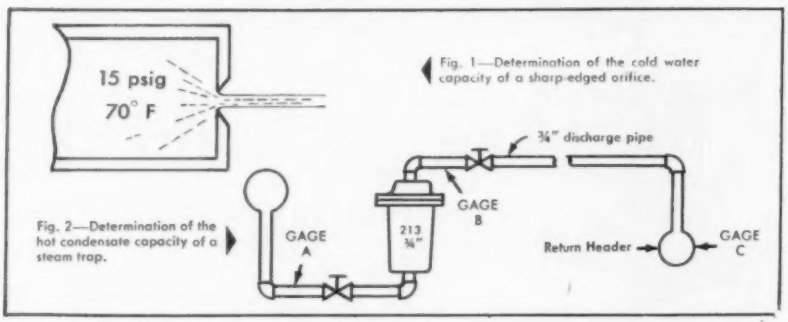

Fig. 1—Determination of the cold water capacity of a sharp-edged orifice.

Fig. 2—Determination of the hot condensate capacity of a steam trap.

Density of condensate. As pointed out above, cold water weighs 62.4 lbs. per cu. ft. At 15 lbs. pressure and 250° F. water weighs less than 59 lbs. per cu. ft. This difference in density alone reduces the lbs. per hour capacity of the orifice by over 5%.

Pressure differential across the trap. With the trap valve closed we have a static pressure differential of 15 psi. The trap valve must be able to open against this pressure. However, this is not the pressure differential that will determine the capacity of the trap valve.

The ¾" discharge line will be full of a mixture of flash steam and condensate. To keep this mixture flowing from the trap outlet to the return line requires a pressure differential. In actual capacity tests run as shown in Figure 2 Gage B at the trap outlet registered 11 lbs. back pressure. Thus the true pressure differential across the trap was about 4 lbs. Under these conditions the measured capacity of the trap was 4,340 lbs/hr. or just about half of the capacity of the ½" orifice for cold water.

How Armstrong Determines Capacity Ratings

Armstrong trap capacity ratings are based on hundreds of tests under actual operating conditions. In these tests, the condensate used was at the steam temperature corresponding to the test pressure. Thus, the capacities determined take into account the pressure drop that occurs when the trap orifice opens and the choking effect and back pressure of the flash steam. Actual installation hookups were used so that pipe friction in both inlet and discharge lines as well was reflected in the results.

Let's go back to the example cited above and in Figure 2. The trap referred to is an Armstrong No. 213. While it did test out at 4,340 lbs. per hour for a static pressure differential of 15 psi, it is rated in the catalog at only 3900 lbs. per hour for this pressure—just to be on the safe side.

For the trap buyer, this means that Armstrong Steam Trap capacities are based on handling condensate at steam temperature for the stated static steam pressure differential under actual working conditions.

Capacity ratings which don't take into account all of the variables will be misleading and may lead to the selection of undersized traps. So whenever you specify or buy traps be sure that the capacity ratings you work from are realistic. One way to be sure is to select Armstrong Traps with *guaranteed* capacity ratings.

* * *

Additional information on trap capacity ratings, plus data on how to correctly size, install and maintain steam traps for any pressure, any temperature and any load, are presented in the 48-page Armstrong Steam Trap Book. Ask your local Armstrong Representative for a copy or write:

Armstrong Machine Works
8101 Maple Street
Three Rivers, Michigan

ARMSTRONG STEAM TRAPS

"See our catalog in Sweet's Plant Engineering File"
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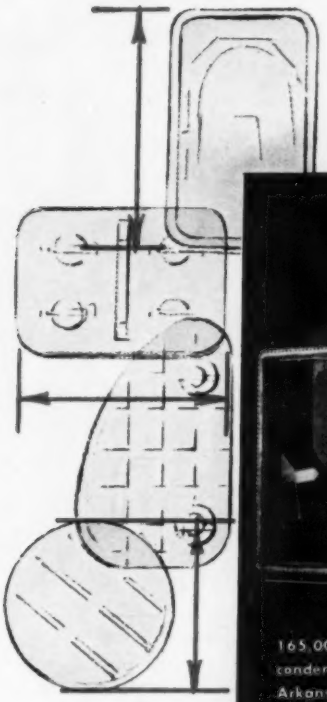
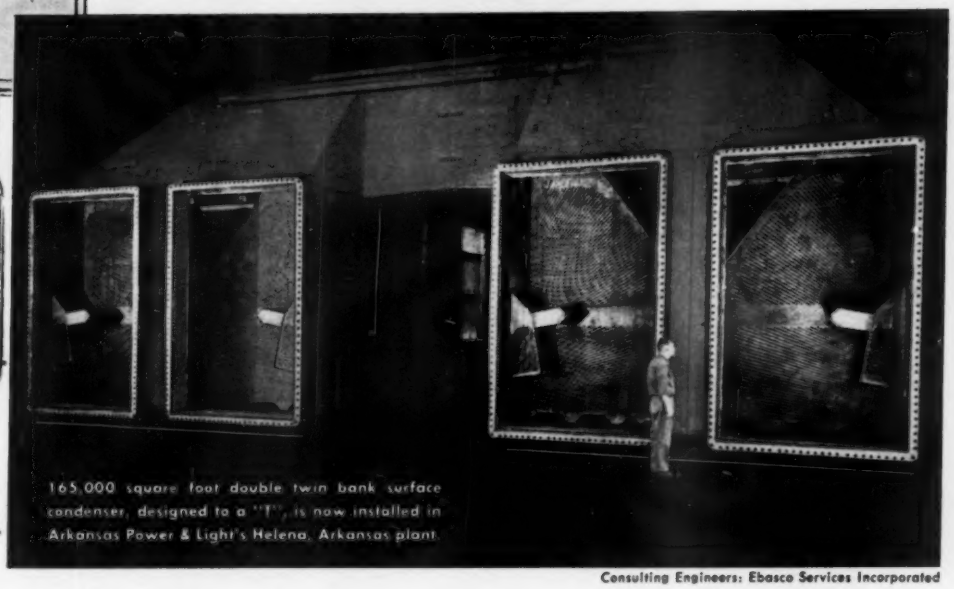


YUBA CONDENSERS
ANY SIZE . . . ANY ARRANGEMENT



165,000 square foot double twin bank surface condenser, designed to a "T", is now installed in Arkansas Power & Light's Helena, Arkansas plant.

Consulting Engineers: Ebasco Services Incorporated

MOST VERSATILE TUBE BANK LAYOUT IN THE INDUSTRY

YUBA SURFACE CONDENSER DESIGN . . . most flexible . . . any size . . . any arrangement. Through design advances such as those incorporated in the unit above, Yuba illustrates the concepts you can expect from years of engineering leadership in the power industry.

Yuba's twin-bank tube layout, seen here in a two shell "T" type installation, promotes unobstructed, equally distributed flow. Through Yuba's patented design, the condensate can be deaerated with oxygen content guaranteed to be less than 0.005 cc per liter.

As a design extra, Yuba staggers the tube support plates – reducing harmonics – eliminating vibration. These are some of the reasons why Yuba surface condensers of all sizes have been installed in plants throughout the world. You'll want to know more about the most versatile tube bank layout in the industry – contact Yuba today.

Other Yuba products for steam power plants include feedwater heaters, evaporators, expansion joints, cranes, tanks, structural steel erection, and scores of other items.

YUBA

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YUBA HEAT TRANSFER DIVISION

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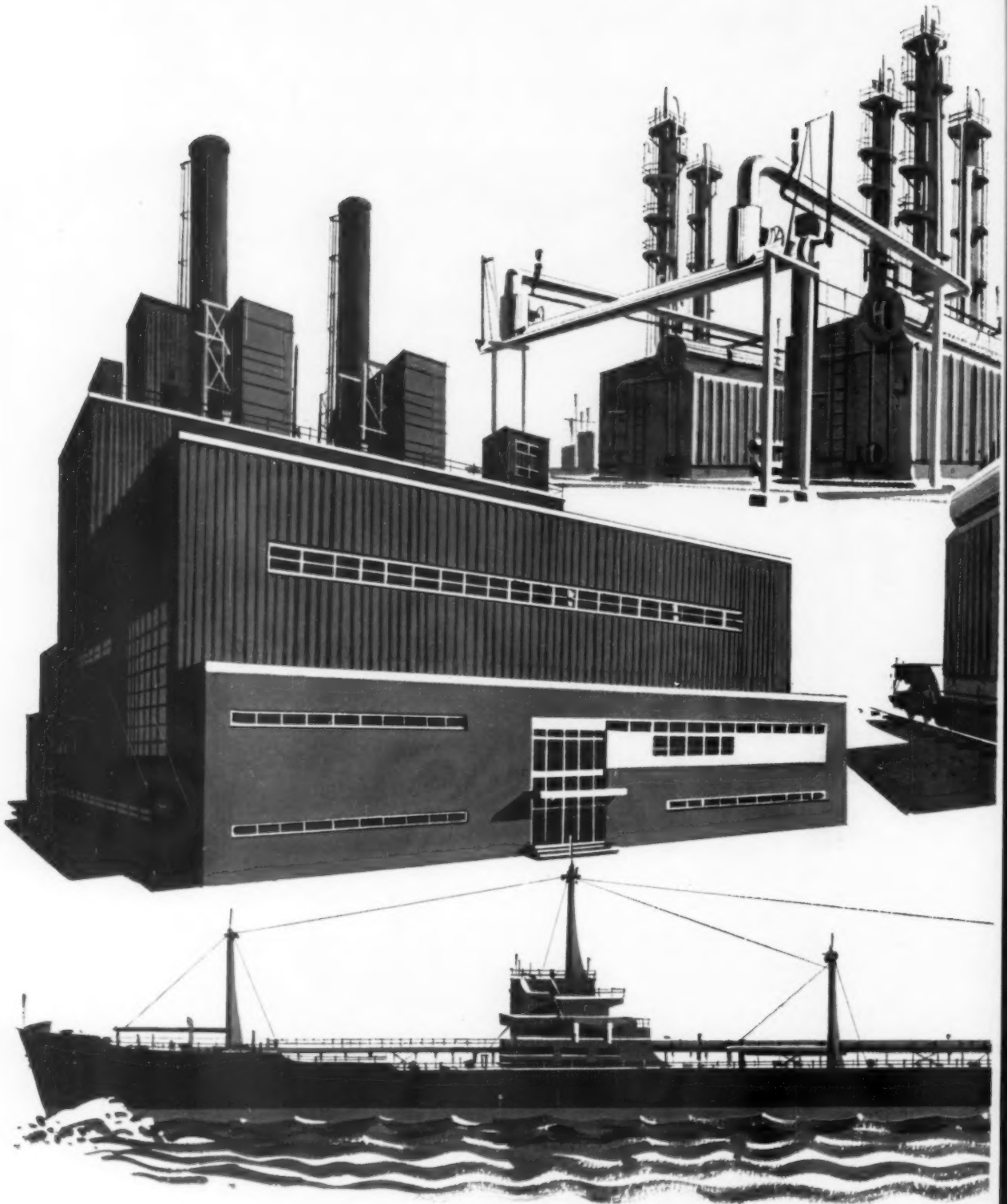

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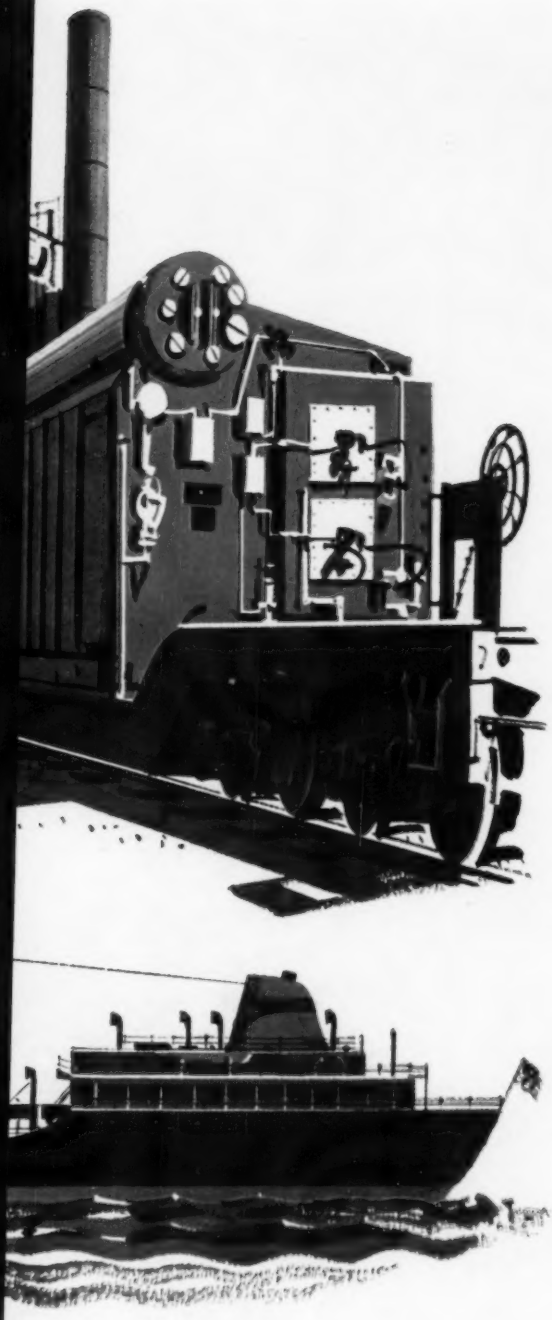

A broader power base to serve you

Through contributions in every field where steam power is used, Foster Wheeler has accumulated knowledge and experience that are yours today in all Foster Wheeler equipment and services.

FW-built steam generating units are identified with the central stations of leading U.S. utilities. Foster Wheeler has designed, engineered and built more nuclear steam generators and pressurizers than any other manufacturer in the world. And FW is the leading U.S. supplier of marine steam generating equipment.

In factories, oil refineries, chemical plants and every other type of installation requiring useful heat, Foster Wheeler is in the top rank of companies supplying heat transfer and steam power equipment.

When such equipment becomes your need, assure yourself of the benefit of FW's broader experience with the *full range* of steam producing components.

FW engineers, fabricates and erects them all: utility and industrial steam generators, feedwater heaters, steam condensers, evaporators, pulverizers, cooling towers, specialized pressure vessels and industrial processing plants. Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, N.Y.

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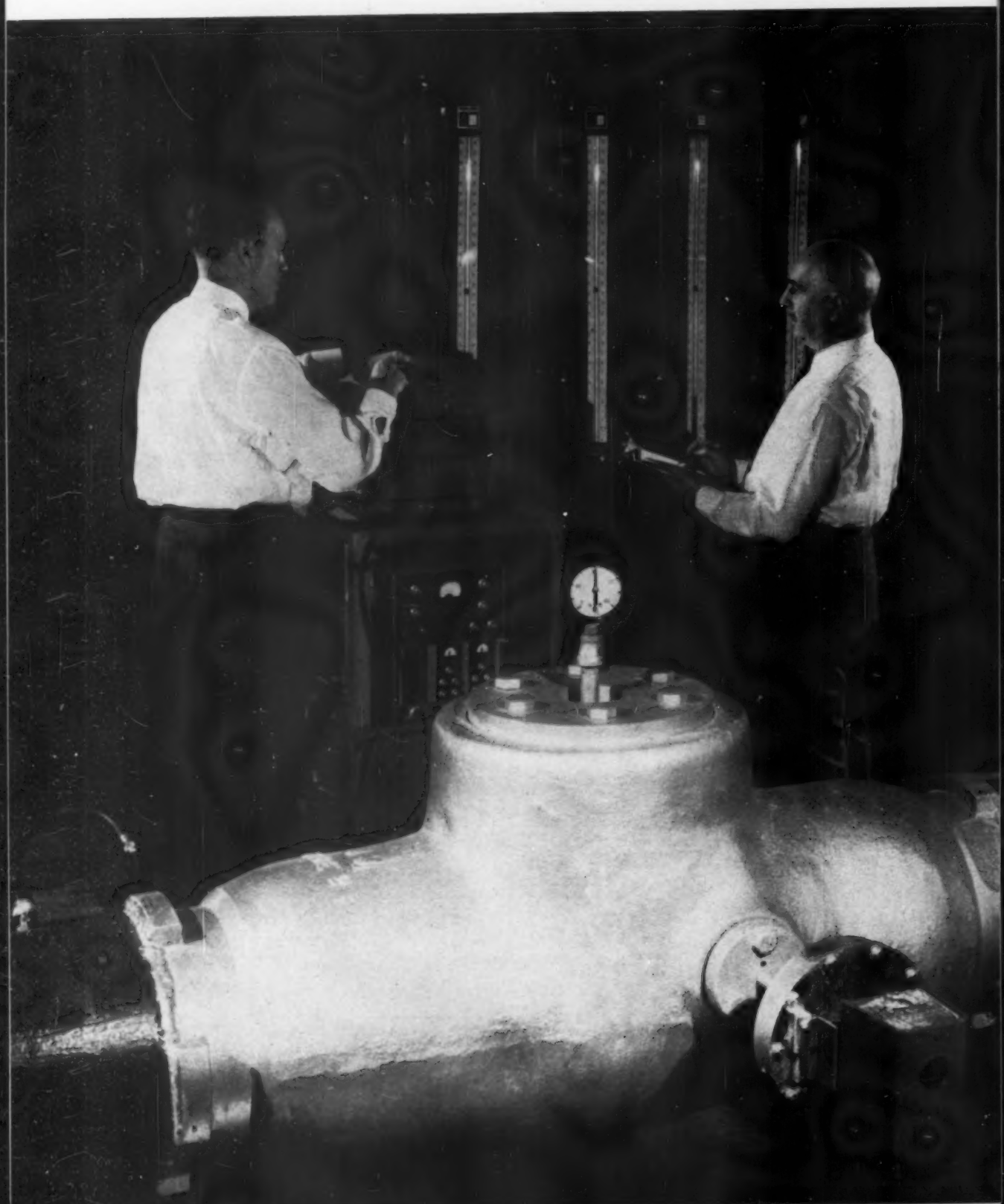
The Story of Edward Research



and the Foolproof Check Valve

The design of the Edward tilting disk check valve started with a single objective: one-piece body construction. Edward designers were convinced that they could achieve this essential objective and, at the same time, assure ease of inspection and maintenance after the valve was welded in the line. Ideally, the valve also had to have these four important operating features: 1) Tight seating; 2) Non-stick operation; 3) Quiet, slamless closing; 4) Low pressure drop. Six years of research and testing gave them these desired features, and made possible this Edward success story.

ONE-PIECE CONSTRUCTION

Both manufacturing and engineering considerations indicated the wisdom of a design with the seat at a right angle to the pipe line. It was also essential that gravity close the disk, whether the pipe was in a horizontal or vertical position. Edward engineers solved this dual problem by welding a counterweight to the disk so that the force of gravity would pull the disk down tight on the seat whether the valve was installed horizontally or vertically. With this new disk idea, the valve seat could be formed of a single circular weld deposit of Stellite, and could be machined and finished through the end of the valve. The resultant one-piece body is virtually impervious to leakage or distortion.

TIGHT SEATING

Getting the disk to seat tightly was especially important because even a small amount of reverse flow was a hazard to pumps and compressors. Edward designers, after experimenting with several pivot positions, pivoted the disk half-way between its center and the upper seating surface. The tapered Stellite-faced disk closes on a tapered Stellite seat in the manner of a globe stop valve. When flow reverses, the larger lower portion of the disk swings downstream while the smaller upper portion swings upstream. Utilizing both gravity and the force of reverse flow, perfect alignment and tight seating are achieved.

SLAMLESS, NON-STICK OPERATION

The unique Edward water flow test loop with its 2,000,000 lb per hour capacity closely simulates actual service conditions. Edward researchers could observe the effects of vibration and water hammer at all stages of tilting disk development. Designing the valve to close quickly—before reverse velocity could build up—virtually eliminated slamming and vibration. Three features make this possible.

First, the disk is dome-shaped to avoid the hesitation of motion characteristic of flat disks. Second, disk travel is minimized by pivoting the disk in the flow stream. Finally, torsion springs enclosed in the pivot pins accelerate closing action from the full-open position. The valve closes efficiently and achieves maximum opening even at lowest flow rates.

LOW PRESSURE DROP

Minimum flow resistance was achieved through painstaking design of all surfaces in the flow line. Full port seat design plus streamlined disk and location of the counterweight out of the flow stream resulted in minimum pressure drop.

A FOOLPROOF VALVE

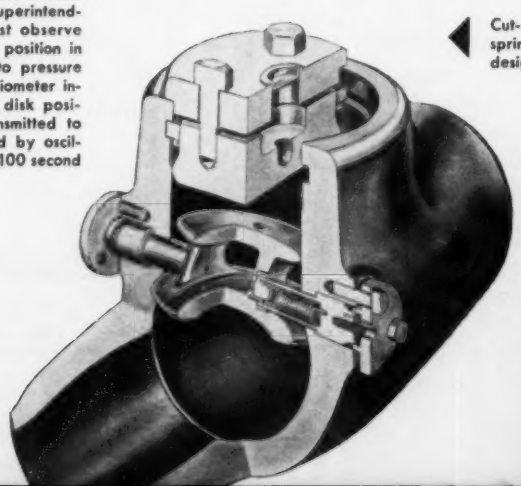
By tackling each problem separately—but always in relation to the entire design—Edward researchers came up with a tilting disk check valve that operated like no other check valve. It was dependable because it always functioned, effective because of its tight seating and low pressure drop, unique because it greatly minimized slamming, vibration, and water hammer.

This is the same tilting disk check valve, developed and patented by Edward Valves, that is so widely used in today's conventional, supercritical and nuclear power stations. Edward Catalog 14-Y gives full details.

Edward builds a complete line of forged and cast steel valves from ¼" to 24" for power, industrial, marine, and petroleum services. For more information, contact your Edward Representative, or write Edward Valves, Inc., 1202 West 145th Street, East Chicago, Indiana. Subsidiary of Rockwell Manufacturing Company. Represented in Canada by Lytle Engineering Specialties, Ltd., 438 St. Peter Street, Montreal. 6023

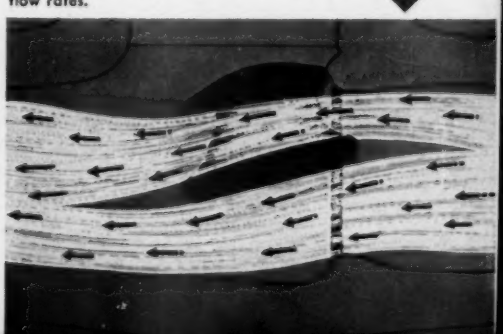
EDWARD STEEL VALVES
another fine product by
ROCKWELL

Director of Engineering and Research L. H. Carr and Plant Superintendent R. E. Rost observe test for disk position in relationship to pressure surge. Potentiometer indications of disk position are transmitted to and recorded by oscillograph in 1/100 second intervals.



Cut-away view of Edward tilting disk check valve shows torsion springs enclosed in pivot pins, pressure seal cover and other design features.

In the open position the disk rests against a stop, thus minimizing disk flutter. Careful design of disk facilitates maximum opening, even at extremely low flow rates.



AUTOMATIC COLORIMETRIC ANALYSIS

in the parts per billion range

Now you can perform delicate colorimetric analyses for silica and other parts per billion trace contaminants right on the plant floor . . . without supervision. Quantichem® Analyzers continuously, automatically perform every step of a wet laboratory analysis with unprecedented accuracy and dependability. The field-proved Quantichem analyzer is so stable and foolproof that it actually provides *greater accuracy and repeatability than tedious manual techniques.*

The first step in each Quantichem analysis is standardization, in which *sample* and *zero* cells are flushed with sample while the instrument zeroes itself. Although no Quantichem analyzer has yet exhibited so much as 1% drift in 24 hours, standardization is a valuable safety feature. It ensures results *independent of photoelectric tube characteristics, line voltage variation, sample turbidity, or dirt on the cell windows.* If a dirty cell window or failing light source prevents zeroing, an automatic signal is actuated.

After standardization, the pneumatic programming drum which controls the instrument actuates the unique Minus Delta P® diaphragm metering pumps. Precise amounts of as many as four reagents (within $\pm 0.25\%$) are delivered to the cells in the desired sequence. The analysis reaction is permitted to go to completion, *eliminating any chance of temperature or timing errors.* The dual beam optical system which illuminates both cells ensures uniform light intensity and *eliminates possible errors due to light source inequality.*

Any difference in light intensity transmitted by the two cells unbalances the measuring bridge circuit, actuating the Quantichem recorder and associated instrumentation. Then a new analysis cycle begins with flushing of the cells and standardization.

Quantichem analyzers are now available for dissolved silica, dissolved oxygen, hydrazine, total hardness, residual chlorine, dissolved iron, and other trace determinations. Most analyses are accurate to within $\pm 3\%$ of full scale, and sensitive to $\pm 1\%$ of full scale. Designed and built to take tough industrial usage, Quantichem analyzers provide long service life with minimum maintenance. All wetted parts are constructed of corrosion-proof materials.

Complete information on them is provided in Bulletin 1156-1, available on request. Write to Milton Roy Company, 1300 E. Mermaid Lane, Philadelphia 18, Pa.

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CHEMICAL INSTRUMENTATION SYSTEMS

Controlled Volume Pumps • Quantichem Analyzers
Chemical Feed Systems • pH Instruments

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Current Catalogs

Valves, Piping, Fittings

101 Valve Guide — Catalog 800-A contains 20 pp of detailed information and technical details on company's bronze valves, as well as pressure and temperature controls, solenoid valves and strainers. Includes descriptive data, comparative chart, estimated weight tables and material standards by Detroit Controls Div., American-Standard.

102 Ductile Iron Valves — General information and specifications on ductile iron valves and fittings manufactured by Stockham Valves & Fittings are presented in 12-pp Catalog 1. Includes comparison of physical and chemical properties and complete engineering specifications.

103 Air Control Valves — Presented in chart form in Bulletin 60-2 by Hoffman Valves, Inc., are two-, three- and four-way five-port poppet type valves. Air and solenoid pilot operators are illustrated and coordinated in the chart with compatible valves.

104 Improved Plastic Pipe — Illustrated 10-pp Bulletin TR-270A, issued by Johns-Manville Corp., contains tables of properties, working pressure, flow chart and other pertinent information for selection of Supreme plastic pipe. Includes tips on cutting, connecting, installing, testing and backfilling.

105 Spiral Pipe, Fittings — Features and advantages of spiral pipe and fittings for high velocity systems made by United Sheet Metal Co., Inc. are illustrated and described in this 8-pp product bulletin. Describes sound absorbing qualities and includes dimensional data.

106 Plastic Pipe — Characteristics and advantages of Johns-Manville Corp.'s plastic pipe are detailed in Bulletin TR-273A. Contains tabular data on physical properties, rated working pressures, sizes and weights, as well as recommended procedure for joining pipe.

107 Transite Pipe — Details on Transite asbestos-cement industrial water pipe are presented by Johns-Manville Corp. in 10-pp Bulletin TR-254A. Performance characteristics, friction loss of head chart and design and specification data included.

108 Non-Corrosive Drainline — Twenty-pp engineering and parts catalog of The Nalge Co. presents the Vulcathene acid and corrosion resistant waste and drainage system of plastic plumbing equipment, covering sinks, traps, pipe and fittings, adapters and other products. Includes technical and dimensional information, installation notes, tables of thread sizes and chemical resistances.

109 Pipe Ratings — Technical Bulletin TB1-1960, 24 pp, offered by The Pipe Fabrication Institute, tabulates pressure-temperature ratings of carbon steel, molybdenum, chrome-molybdenum and chromium silicon molybdenum alloys in all standard sizes of seamless piping. Chemical requirements, in relation to the various types of seamless pipe and weight charts, are included. Available to qualified power engineers, please state your title.

110 Strainer Selection — Twelve-pp Catalog 6008, Leslie Co., on self-cleaning strainers for steam, air, gas, and liquids, details over 600 standard strainers and shows selection of body materials and connections, pressure ratings and sizes. Pressure-drop and pressure-temperature limit data provided. For simplified ordering, body materials, end connections and ratings are tabulated and keyed to a single catalog number.

111 Rotary Union — Featured in 20-pp Bulletin 700 by Perfecting Service Co. is a revolving connection that forms a positive seal between a stationary supply line and revolving equipment. Includes detailed engineering data, and a diagram of typical installation.

Water Conditioning

112 Water Demineralizers — Six-pp Bulletin 154 introduces disposable cartridge-type water demineralizers designed by Barnstead Still and Sterilizer Co. for use in chemical, electronic, nuclear, laboratory, research and pilot plant operations. Descriptive details on models for a variety of applications are included.

113 For High Makeup Boilers — Selection of water treatment equipment for use at different boiler pressures and with different types of water is the subject of 10-pp Technical Reprint T-183 of Graver Water Conditioning Co. Examines four basic types of treatment and their use in typical plants; includes diagrams and illustrations of equipment.

Pumps, Compressors

114 Centrifugal Pumps — Single stage, double suction centrifugal pumps are described by Goulds Pumps, Inc., in 16-pp Bulletin 721.6. Complete specifications, interchangeability chart, performance curves and dimensions are included.

115 Vertical Turbine Pumps — Features and advantages of Worthington Corp.'s ultra high flow vertical turbine pumps are detailed in 16-pp Bulletin 2400-B1. Cutaway views showing component details are included along with selection data and illustrations of different drive arrangements available.

116 For Leak-Proof Pumping — Bulletin 2050, released by Chempump Div., Fostoria Corp., describes features of the Series G Chempump . . . automatic thrust balance, large bearings, oil filled stator cavity. Also includes performance curves and detailed cross-section of the pumps.

117 Jet Compressors — Bulletin 4F, issued by Schutte and Koerting Co., contains 16 pp of detailed information on jet compressors, including fixed-nozzle, manually controlled spindle, and automatically controlled spindle types. Covers construction, operation and application and includes nomographs to determine possible weight ratio of secondary gas to primary gas and to determine compressor size.

Dust Control

119 Dust Collection, Recovery — Details on dust collecting, recovery and classifying equipment manufactured by Buell Engineering Co., Inc. are presented in this product bulletin. Covers electric precipitators, mechanical collectors, bag collectors, and combination systems.

New and revised publications reviewed on these pages offer help on operating and maintenance problems. To order, use the handy Reader Service Cards provided on pages 91 and 92.

120 Electrical Precipitator — Development and basic steps of electrical precipitation are detailed by Aerotec Industries, Inc., in 8-pp Bulletin A1-101. Covers charging, precipitating and discharging dust particles, back-ionization problem, and suggested energy sources.

Mechanical Power Transmission

121 Adjustable Speed Drives — Six-pp Bulletin 2900 describes The Louis Allis Co.'s four types of packaged adjustable speed drives and gives details on available ratings, speed ranges, type enclosures, associated controls and standard and special modifications. Specifications included.

122 V-Belt Guide — Design features and performance advantages of company's V-belts for heavy and light duty, short and long center applications are detailed in 8-pp Bulletin M-201 by Manhattan Rubber Div., Raybestos-Manhattan, Inc. Includes ordering information and specifications, and illustrates advantages of straight sidewall construction.

123 Industrial Brakes — Bulletin CE-410 describes Ederer Engineering Co.'s DC Series magnetic brakes for general use in industry and Bulletin CE-420 describes their positive acting solenoid brakes for general industrial use. Ratings and clearances are given.

124 Holdback Clutches — In this 12-pp catalog, Formsprag Co. describes holdback clutches designed to prevent runback or reverse travel of inclined conveyors, bucket elevators, capstans and related handling or operating equipment. Tells why and where these clutches are used; explains how they operate, and cites major design advantages. Provides tables and charts covering speed and idler factors, and engineering, dimensional and mounting data on 12 models, bore sizes from 1 15/16 to 12 in.

125 Torsionally Resilient Couplings — Detailed information on The Falk Corp.'s torsionally resilient Steelflex couplings is presented in 24-pp Bulletin 4100. Charts and tables contain engineering data and photos and diagrams illustrate design and construction features.

126 Ball Bearings — Wide inner ring ball bearings and power transmission units are illustrated and described in 60-pp Catalog 480 by The Fafnir Bearing Co. Contains specification charts and diagrams on the ball bearings as well as on pillow blocks, flange cartridges, cylindrical cartridges and take-up units.

Instruments, Controls

127 Industrial Controllers — Pneumatic and electric controllers for a variety of process applications are illustrated and described by Minneapolis-Honeywell Regulator Co. in 56-pp Catalog C-15-2a. Covers modular design features as well as proportional plus reset plus rate control units, partial chart listings, and pneumatic and electric contact control forms.

128 Recording Type Controller — Bulletin 335, issued by Stickle Steam Specialties Co., describes recording type controllers designed to maintain desired pressure or temperature of steam or liquids. Table of approximate dimensions and diagrams are included.

129 Liquid Level Gage — Bulletin CP3709 describes the Varec Fig. 8400 Series Dynamatic, a liquid level gage for working pressures to 300 psi. Published by The Vapor Recovery Systems Co., bulletin tells how electric power drive utilized eliminates errors due to friction, and use of a displacer does away with float problems. Explains operation and features of this high-pressure tank gage, claimed lower in cost than comparable units.

130 Totalizing Flow Meter — Bulletin Ref. 400.20-1, issued by B-I-F Industries, Inc., describes a totalizing flow meter for steam, air or gas. Cutaway drawing showing component details is included along with typical specifications.

131 Air-Actuated Control — Twelve-pp Bulletin SF-755-A describes features and operation of the FultroMatic air-actuated controller made by Fulton-Sylphon Div., Robertshaw-Fulton Controls Co. Photos and diagrams illustrate operation and applications and tables give specification data.

132 Differential Producers — Illustrated and described in 8-pp Bulletin 0100.20 by B-I-F Industries, Inc., are ten differential producers covering a range of applications. Flow tubes, venturi tubes and flow nozzles, Parshall flume liner and others are presented. Covers products suitable for metering of water, air or gas, petroleum, alkalies, acids and sewage.

133 Combustion Control Systems — Design and selection of combustion control systems is covered in 32-pp Bulletin 1001 by Reliance Instrument Div., Electro-Mech Corp. Covers proportioning and metering systems, with block diagrams, pointing out advantages, operation and suggested mounting procedures.

134 Boiler Water Columns — Data Unit 395, issued by Jerguson Gage & Valve Co., explains and illustrates alarm mechanism of their water columns which has weights supported on hardened tool-steel knife-edges. Explains operation.

135 Boiler Cleaning Control — Details on automatic boiler cleaning control systems are presented by Diamond Power Specialty Corp. in 14-pp Bulletin 2148. Includes specifications on standard control panels and shows some possible combinations, as well as custom-built control panels designed for specific applications.

Automation

136 Automatic Programming Systems — Details on automatic programming systems by Bendix Computer Div., The Bendix Corp. are presented in 8-pp Bulletin AR-1060. Characteristics of various systems designed to solve a variety of programming problems are covered.

137 Computer Technology — Latest advances in computer technology and equipment are presented by Computer Systems, Inc. in "New Solutions in the Science of Simulation," 20 pp. Features the Dystac (Dynamic Storage Analog Computer), a hybrid computer combining analog computer's speed, lower cost, ease of programming and improved output data presentation, with digital computer's capacity for data storage and time-sharing of components.

Electrical

138 Synchronous Motors — Product Publication 1100-PRD-247 describes vertical synchronous motors from 250 hp and up manufactured by Electric Machinery Mfg. Co. Cutaway views showing component details are included.

139 Electric Motors — Featured in 8-pp Bulletin 2651 by The Louis Allis Co. are a-c and d-c motors, special motors and gearmotors. Describes applications, available ratings, enclosures and modifications.

140 Fhp Motors — Detailed information on a fractional horsepower motor is presented by The Reliance Electric & Engineering Co. in 8-pp Bulletin B-2514. Advantages and characteristics are detailed and specifications given.

141 Multi-Speed Motors — Principal types of multi-speed motors — variable-torque, constant-torque, constant-horsepower — are featured by Century Electric Co. in Bulletin 1300. Both polyphase and single phase types are covered and typical ratings given.

142 Unit Substation — Features and advantages of General Electric Co.'s load center unit substation with low voltage switchgear are detailed in 6-pp Bulletin GED-4269. Includes photos and isometric view of switchgear compartmentation.

143 Load Centers — Descriptions, wiring diagrams, dimensions and selector tables for The Bryant Electric Co.'s circuit breaker load centers are presented in 20-pp Catalog C-200. Features and advantages of the circuit breakers are illustrated.

144 Transformer Tips — General information, operating and maintenance tips and connections for pole type distribution transformers are presented by Allis-Chalmers Mfg. Co. in 52-pp Pocket Manual 61X9659. Includes helpful tables and engineering charts.

145 Service Entrance Equipment — Operating and safety requirements of service-entrance equipment are detailed by Pringle Electrical Mfg. Co. in 6-pp Bulletin 601. Covers three basic aspects of service-entrance function: current-carrying efficiency, manual switching facility, and speed of short-circuit interruption.

146 Distribution Transformers — Features, operation, application and maintenance of General Electric Co.'s large distribution transformers (single and three-phase, 167/187–500/560 kva, 15 kv and below) for commercial and industrial distribution are described in 12-pp Bulletin GEA-7153. Weight and dimension tables and other data are included.

147 Carrier-Current Systems — In 8-pp Bulletin GEA-7204, General Electric Co. describes power-line carrier-current equipment for electric utilities, including transmitter-receivers for general purpose and supervisory control, relaying, telemetering and communications; coupling capacitors and potential devices, and aluminum line traps.

148 Current-Limiting Fuses — Application information on General Electric Co.'s current-limiting power fuses, rated 600 to 34,500 v, is presented in 8-pp Bulletin GEA-7137. Includes photos, cutaway drawings and graphs showing components and operational characteristics.

149 Limit Switches — Twelve-pp Bulletin GEA-7312 describes General Electric Co.'s limit switches for automatic pilot control. Includes application guide, switch terminology, selection and installation guides, and discusses typical applications of lever, leverless and rotating cam and limit switches, as well as tripping forces involved for activation of each switch and other details.

150 Power Protector — Bulletin GEA-6527-1 illustrates features that permit safer entrance up to 480 v a-c with General Electric Co.'s power protectors. Charts and sketches show advantages of service entrance with interrupter switch.

When ordering catalogs, allow time for us to relay your requests to the manufacturers — and for them to mail out copies. Remember, manufacturers are often swamped with catalog requests.

151 Trolley Busway System — Detailed information on steel-enclosed trolley busway electrification system is presented in 40-pp Bulletin 90 by Feedrail Corp. Describes track, trolleys and accessories; covers features and advantages; and includes installation data, methods of mounting and typical layouts.

152 Electrical Testing Instruments — Twelve-pp Catalog 10-1.3 covers instruments for maintenance, installation and proof-testing of plant electrical equipment. Included are dielectric breakdown tests sets from heavy duty types with a-c or d-c potentials to 150 kv, through mobile, bench and hand-carried portable models. Megohmmeters with ranges to 5,000,000 megohms are presented, also ground resistance testers, special purpose instruments. Booklet is offered by Associated Research, Inc.

153 Ribbon Cable — Multi-conductor parallel ribbon cable with color coded conductors is described by Westwood Cable Corp. in this product bulletin. Selection table is included.

more Current Catalogs page 89

Another addition to the Vogt line of TOP QUALITY valves . . .

Forged Steel
WELDED BONNET

GENERAL GP PURPOSE

Gate and Globe
VALVES

150-800 Pounds Service

To eliminate forever potential body-bonnet leaks, Vogt engineers have developed these new General Purpose valves with seal welded bonnet joints.

This new addition to the world's most complete line of forged steel valves incorporates all the features of other Vogt GP valves—hard faced seats, hardened stainless steel wedges, drop forged pressure parts, and the numerous other advantages of Vogt's valve line.

The desirable safety feature of a back seat on the stem is retained while still offering the elimination of a possible body-bonnet leak.

Available NOW in both gate and globe types, ¼" thru 2", and in both socket weld and screw ends. These are priced identical to the bolted bonnet GP valves; gate valves the same as Series 12111 and globe valves the same as Series 12141.

Address Dept. 24A-FPE for literature

Series 2801 Gate Valve
Illustrated

Series 2821 Globe Valve
Also Available

Both series identical in dimensions and have 13% chrome stainless steel trim.

HENRY VOGT MACHINE COMPANY, Louisville, Ky.

SALES OFFICES: New York, Chicago, Cleveland, Dallas, Camden, N. J., St. Louis, Charleston, W. Va., Los Angeles.

Vogt GENERAL GP PURPOSE Vogt FOR BETTER VALVES

FORGED STEEL
VALVES

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NEW YORK CITY, N. Y.
WALTER HART, *Co-ordinating Architect for KLM*

Consulting Engineer:
EBNER ASSOCIATES,
NEW YORK CITY, N. Y.

Electrical Contractor:
DAVIDSON ELECTRIC CO.,
BROOKLYN, N. Y.

General Contractor:
TURNER CONSTRUCTION CO.,
NEW YORK CITY, N. Y.

Electrical Protection *is MODERNIZED* with BUSS fuses in the KLM Royal Dutch Airlines Building, New York City

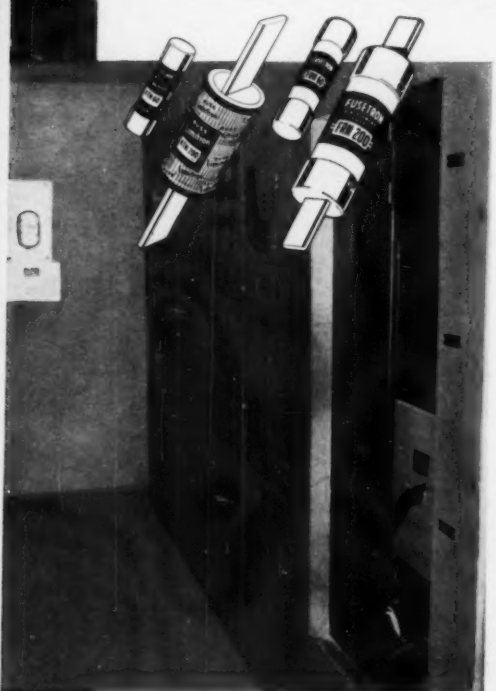
KLM INSTALLATION POINTS OUT THE NEED FOR SAFE INTERRUPTION OF HIGH FAULT CURRENTS

A 3 million dollar modernization program was recently completed on this 13 story office building at 609 Fifth Ave., which houses the American Executive and first floor ticket offices of KLM Royal Dutch Airlines.

To meet power requirements, the capacity of the electrical system was greatly increased, resulting in an estimated available fault current level approaching 100,000 amperes.

In the main switchboard, Buss LIMITRON fuses are installed to provide the high interrupting capacity necessitated by the available fault current and to give great current limitation needed to protect circuits and equipment.

To further assure safe protection and to safeguard against needless outages, distribution and feeder circuits are equipped with FUSETRON dual-element fuses.



Part of Main Switchboard Protected by:
3-3000 amp., 3-1200 amp., 6-1000 amp.,
BUSS LIMITRON FUSES and
15-400 amp., 3-350 amp., 3-275 amp.,
3-250 amp., 9-200 amp., 3-125 amp.,
3-90 amp.,
FUSETRON dual-element FUSES

Fuses Offer the Safest, Most Practical Solution to Modern Protection Requirements

As electrical network capacities increase, available fault currents of 75,000 to 100,000 amps and up are no longer uncommon.

In order to adequately safeguard circuits and equipment, it becomes imperative to install protective devices that can safely interrupt these fault currents.

HIGH INTERRUPTING CAPACITY

Fuses provide high interrupting capacity at a very low cost. Buss LIMITRON fuses have an interrupting rating of 200,000 amps. rms symmetrical — and for FUSETRON dual-element fuses it is 100,000 amps.

CURRENT LIMITATION

Buss LIMITRON fuses also provide current limitation so that fault currents are shut-off before equipment on the circuit can be damaged.

LIFE-TIME DEPENDABILITY

Fuses remain safe and accurate through the years. Fuses have no triggers, latches, pivots or contacts to stick or get out of order. They require no expensive maintenance or recalibration — they are always ready to function the instant trouble occurs.

To help you select the proper fuse, write for the new BUSS booklet . . .
BASIC PROTECTION FOR ELECTRICAL POWER SYSTEMS.

BM1

BUSSMANN MFG. DIVISION *McGraw-Edison Co.*
University at Jefferson, St. Louis 7, Mo.

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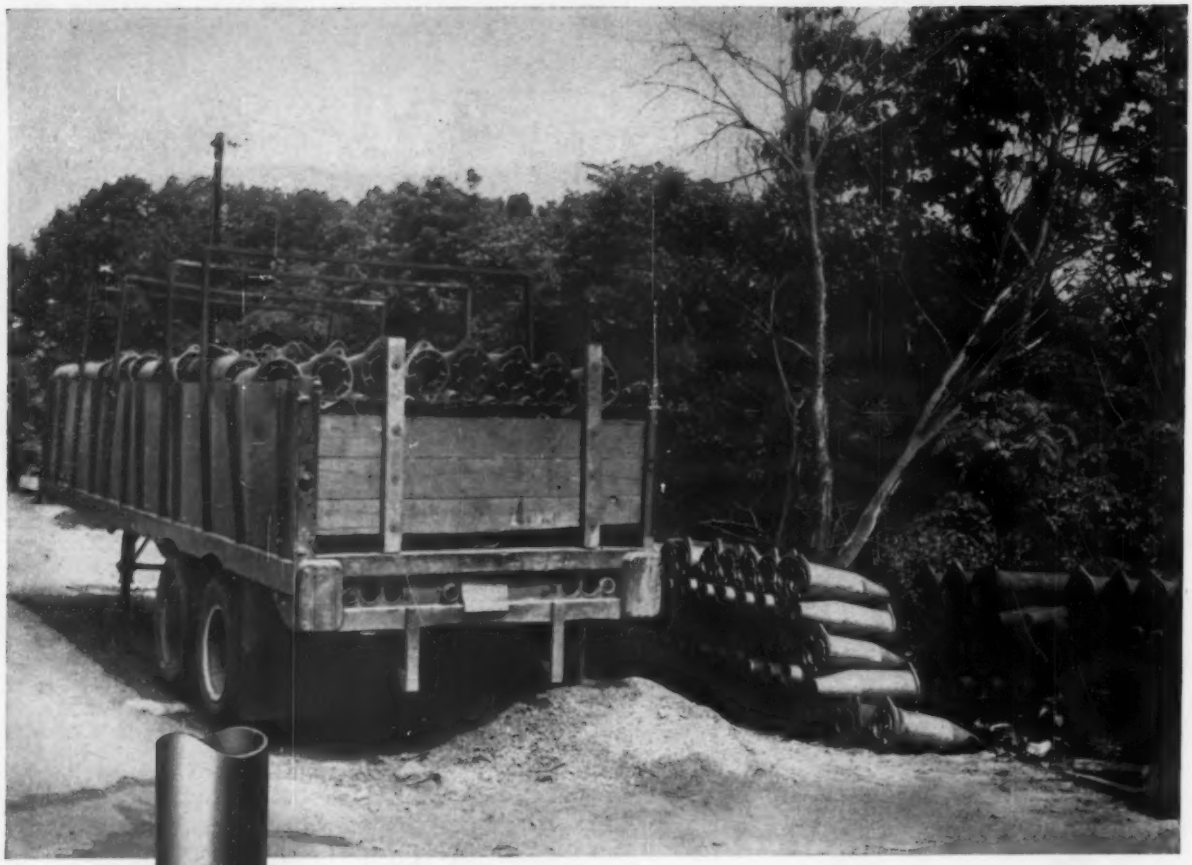

TYPE
C10
CYCLO-TRELL

Ammunition for the war on dust!

Fighting dust is the purpose of this load of Cyclo-trell C10 "shells." ■ Cyclo-trell units for process gas or air cleaning in steel mills, refineries, paper, cement or chemical plants give you high efficiencies. ■ Engineered to fit each specific job, Cyclo-trell units are available in a wide range of sizes and types including C10, C24, IC (Involute Cyclo-trell) and ICL (Involute Cyclo-trell, Lined). ■ Why not let us consult with you on your specific dust collection problems? For further information, write for Bulletin 300 which describes several applications in detail.

Research-Cottrell

RESEARCH-COTTRELL, INC., Main Office and Plant: Bound Brook, N. J.
Representatives in principal cities of U.S. and Canada

RESEARCH COTTRELL INC.
TRADE MARK
RC-209

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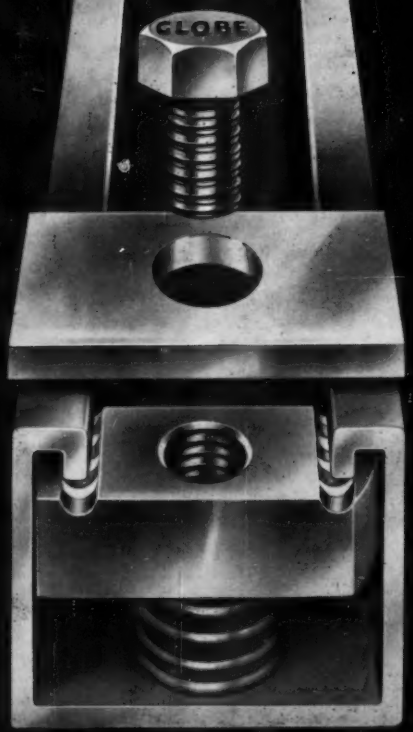
GLOBE

CHANNEL AND FITTINGS

The Superior System of

CHANNEL FRAMING

GALVANIZED



- *A fitting for every purpose*
- *Triple grip nuts for greater strength*
- *For any framing or suspension use*
- *Set-up with a hacksaw and wrench*
- *Completely re-usable – unlock and set-up again*

Write for literature.

PRODUCTS DIVISION

THE GLOBE COMPANY • 4022 S. PRINCETON AVE • CHICAGO 9, ILLINOIS

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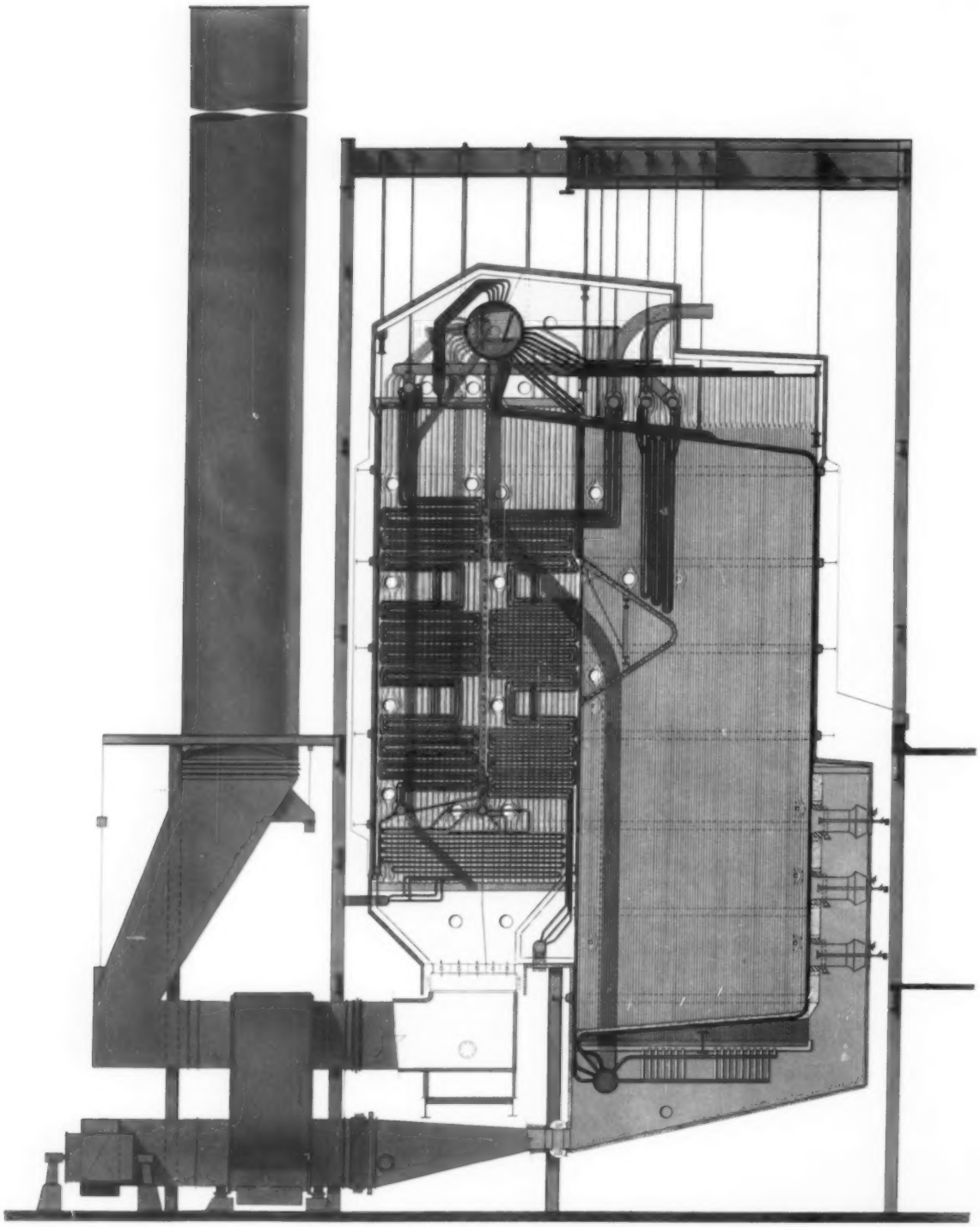


A careful survey of your plant by a qualified consulting engineer could show ways of making substantial savings in power costs.

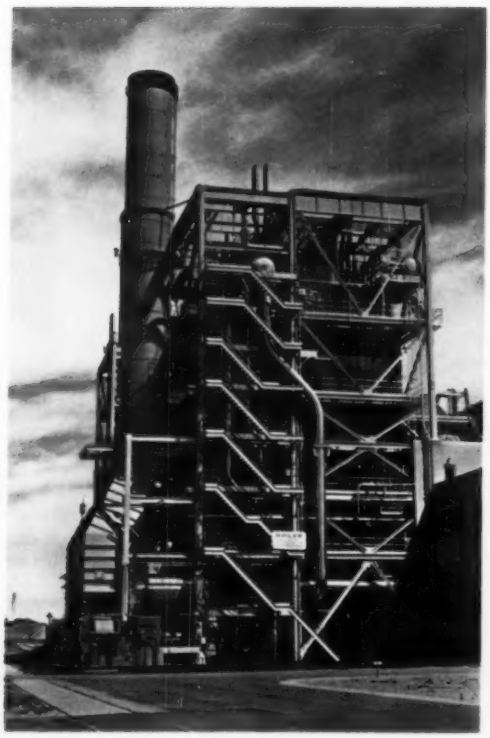
Another RILEY Boiler in Texas Helps to Boost Productivity in the Lower Rio Grande Valley

No. 2 Boiler
J. L. Bates Power Station
Central Power and Light Company

Engineering Data

Steam Capacity — 750,000 lbs/hr
for 4 hours — 800,000 lbs/hr
Design Pressure — 1750 psig
Superheat — Reheat 1005/1005F
Steam Temp. Control — Spray, Dampers
Fuel — Gas and Oil
Pressurized Setting
Efficiency — 88.10%

Sargent & Lundy
Consulting Engineers



During 1960 Central Power and Light Company, Corpus Christi based Texas utility, completed an extensive expansion program to its system with the installation of the No. 2 unit at J. L. Bates Power Station near Mission, Texas in the Rio Grande Valley. This unit adds 110,000 kilowatts to the system capability, bringing it to 953,000 kw — five times the capability of 10 years ago.

The Riley Reheat Boiler was selected as a result of a program designed to lower the cost of kilowatt production and to offset the increase in the cost of fuels.

Central Power and Light Company is one of several Texas utilities using Riley boilers. A total of over 16 million pounds of Riley steam has been purchased by utilities for Texas central stations since 1950, indicating the industry's remarkable growth, and increasing acceptance of Riley steam generating and fuel burning equipment.

RILEY UTILITY BOILERS IN TEXAS (Installed and on order)

HOUSTON LIGHTING & POWER CO.	11 Units —	6,440,000 lbs/hr
TEXAS ELECTRIC SERVICE CO.	4 Units —	5,861,000 lbs/hr
DALLAS POWER & LIGHT CO. .	3 Units —	3,450,000 lbs/hr
CENTRAL POWER & LIGHT CO.	1 Unit —	725,000 lbs/hr
SOUTHWESTERN POWER CO. .	1 Unit —	650,000 lbs/hr
SOUTHWESTERN PUBLIC SERVICE	1 Unit —	330,000 lbs/hr

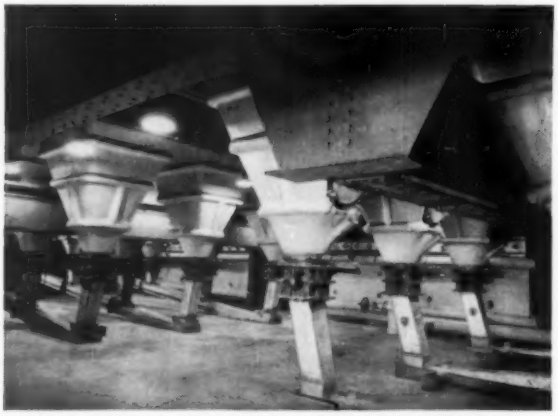
RILEY

STEAM GENERATING & FUEL BURNING EQUIPMENT

RILEY STOKER CORPORATION, WORCESTER, MASSACHUSETTS.

Sales Offices:
Boston, Charlotte, Chicago, Cincinnati, Cleveland, Denver, Detroit, Houston, Jacksonville, Kansas City, Los Angeles, New Orleans, New York, Philadelphia, Pittsburgh, Portland, Salt Lake City, San Francisco, St. Louis, St. Paul, Seattle, Syracuse.

How Commonwealth Edison Turned a Fly Ash Problem Into Profit



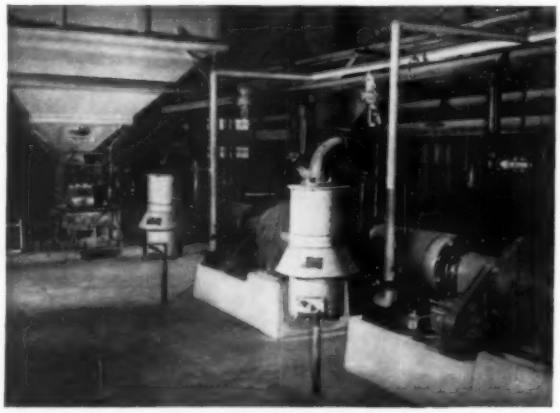
F-H AIRSLIDE FLUIDIZING CONVEYORS ANGLE DOWNWARD from precipitator hoppers, move air-activated ash to 20-ton central surge hoppers under floor. There are few moving parts.

At Commonwealth Edison's State Line Station, about 350 tons of fly ash a day had to be wet down, loaded, and trucked to suitable dumping sites.

Waste becomes profit. Today, the plant burning a peak load of 5000 tons of coal daily collects dry fly ash automatically in a totally enclosed Fuller-Kinyon system. The ash is conveyed from precipitators to storage bins and silos, where it's sold as a by-product. Manpower: just three men, one at the main control panel and two bagging the ash.

Air and gravity do the work. F-H Airslide® conveyors fluidize dry fly ash by a column of low-pressure air for easy movement by gravity to central surge hoppers. Then, a Fuller-Kinyon pump under each hopper drives the ash by air through a five-inch line to storage. The system is practically maintenance-free. There are few moving parts to foul or wear out.

Large and small plants can get the benefits of Fuller-Kinyon fly ash handling. Capacities range from 100 to 8,000 cubic feet an hour. F-H Airslide and Fuller-Kinyon conveying lines can be curved to avoid beams and other obstacles. Low-pressure air provides power inexpensively and installation costs are significantly less than other types of conveying systems. Write for detailed information in Bulletin FF-49-1.



FULLER-KINYON PUMPS AND COMPRESSORS under surge hoppers propel ash to bins and silos at 20 tons an hour. Fluidized by air, the abrasive, 300°F. ash moves without injuring system.

BULK SILOS receive air-conveyed ash through Fuller-Kinyon pipe-lines. Farthest silo is 1,000 feet from pumps. Over 50% of fly ash is bagged and sold as a by-product.

1335A
G-203 A

Fuller
....pioneers in harnessing AIR

FULLER COMPANY
150 Bridge St., Catasauqua, Pa.
Subsidiary of General American Transportation Corporation
Offices in Principal Cities Throughout the World

FULLER COMPANY GENERAL AMERICAN TRADE MARK

"See Chemical Engineering Catalog for further details and specifications."

For more data circle 523 on Post Card

Hall Industrial Water Report

VOLUME 9 APRIL 1961 NUMBER 2

There's nothing fishy about scale

Ask the power engineer who has boilers down because of blistered tubes. The maintenance man who has to push a screaming turbine through the dirty tubes. The refinery superintendent who has to stop a campaign because of scale. Or the plant manager who has to approve the bills for acid cleaning.

Deposits formed from water range from simple to complex compositions. Some are easy to prevent. Others are a real challenge. Hall engineers know what each constituent means and the water conditioning procedures which are effective in controlling deposition in power plants, cooling systems, service water systems, or manufacturing processes. They can help you.

Poor testing

Hall field engineer C. H. Turner was asked to investigate a rash of boiler tube failures at a midwest paper mill. He found that the failures were due to a type of scale that will not form in the presence of an adequate amount of phosphate in the boiler water—but the plant reported that phosphate concentration had been satisfactorily maintained.

Turner suspected the phosphate testing procedure. A check quickly determined that an important step in the phosphate test was being omitted, and phosphate feed was actually insufficient to prevent scale formation. Considerable trouble and expense could have been avoided if Hall service had been available *before* the tube failures occurred.

Time marches on

A metals refining plant has been a satisfied client of Hall Laboratories for more than twenty years. But Hall has not been completely happy with results.

Hall field engineer R. A. Beardsley knew that he could get cleaner boilers. However, he could not generate enthusiasm for the necessary changes, because results were good enough to prevent serious trouble.

Beardsley finally broke the barrier. Boiler water conditions were modified, modern chemical feeding equipment was installed and testing procedures and equipment were brought up to date.

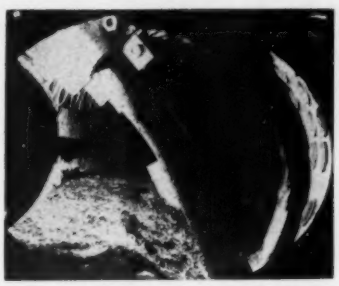
The changes paid off. The next insurance inspection report was the best ever. Hall engineers are constantly applying new procedures and ideas to old problems.

Dirty jackets

Well water, high in temporary hardness, is used for cooling diesel engines under test at an eastern engine manufacturing plant. The duration of test runs is only about 18 hours over a two-day period, yet calcium carbonate scale built up rapidly enough to result in engine overheating and damage. Jacket cleaning with acid before shipment was standard practice.

When Hall field engineer D. C. Altenburger tackled the problem, he found that he would have to consider oil contamination of the cooling water as well. Furthermore, if he used threshold treatment with sodium hexametaphosphate to control precipitation of calcium carbonate, he would be in trouble with calcium phosphate deposits because of the high temperature (175-185°F) of the circulating water.

Altenburger concluded that he would use threshold treatment, plus an organic dispersive for calcium phosphate, plus a wetting agent to combat the oil. Results have been excellent. Deposits are a thing of the past and there is no longer any engine damage during test runs or need for cleaning.



Before and after

The "Before" picture shows the mud drum of a boiler in a midwestern machinery plant almost half full of scale. This was the condition found after operation for one year with presumably good boiler water conditions.

After cleaning the boiler as thoroughly as possible by mechanical means, the operators retained Hall Laboratories. Hall field engineer J. D. Crail studied the problem and helped the operators set up protective water conditions.

There was enough scale left in the boiler to double theoretical chemical consumption for almost six months. Then chemical feed dropped steadily. When the boiler was opened after approximately ten months, everyone was happy to find the condition shown by the "After" picture. Scale formation was no longer a problem.

For your copy of 24-page brochure describing the many ways industry can use Hall Industrial consulting service, write to:

HALL LABORATORIES
HAGAN CENTER, PITTSBURGH 30, PA.
Consultants on Procurement, Treatment, Use and Disposal of Industrial Water

DIVISION OF **HAGAN** CHEMICALS & CONTROLS, INC.

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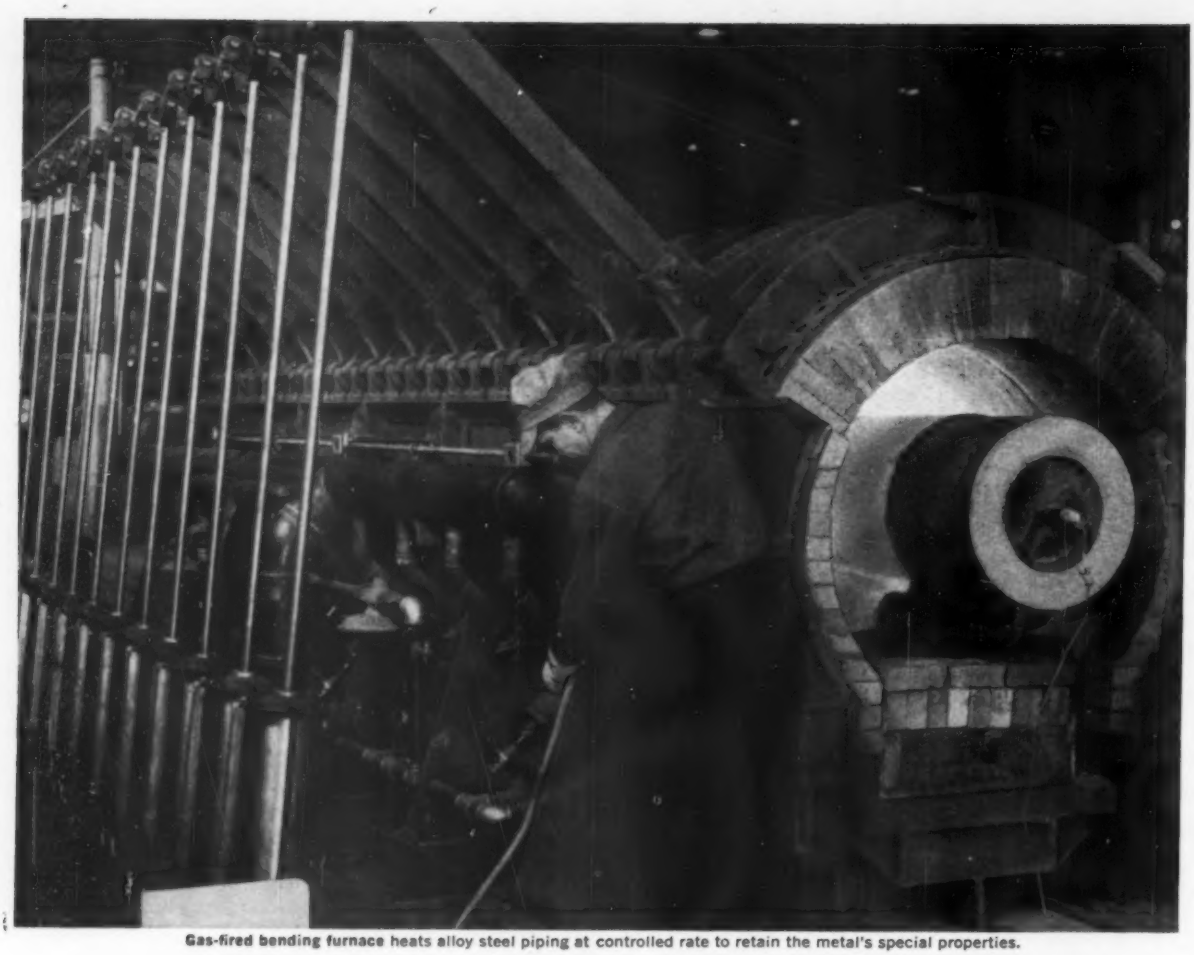

Gas-fired bending furnace heats alloy steel piping at controlled rate to retain the metal's special properties.

Grinnell shop-fabricated piping is 3 ways better than field-fabricated piping

1. Strict quality control. Piping fabricated in the Grinnell shop is made under the strictest quality control . . . with the help of interpretive engineering, metallurgical research, skilled personnel, specialized facilities and rigid inspection at every critical step. Piping fabricated in the field is not made under these ideal conditions.

2. One-company responsibility. Shop-fabrication by Grinnell makes one experienced organization responsible for material procurement, engineering, fabrication and delivery. These many interrelated factors are kept in balance to give you quality at an economy price — no runaway costs.

3. Costs known in advance. With Grinnell, you know all costs — including shop sketches and planning, materials, power services, expendable tools and supplies — *before* you start the job.

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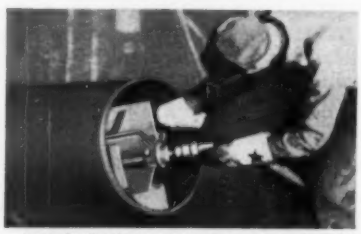

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ATOMICS

A section of POWER ENGINEERING covering current and forthcoming developments in the field of Nuclear Power throughout the world

ANDREW W. KRAMER

Editor

Plan for Maintenance of Insulation On Containment Structures

In Part I* of this article the author discussed the statistical sampling plan to be used in setting up a maintenance program for insulation on containment structures. Now, in this second part, he presents the details of its practical application

By H. H. NORDEN

General Electric Knolls Atomic Power Laboratory

THE FIRST STEP in sampling would be to divide the surface to be sampled into convenient squares, say one square foot. Each square should be assigned a number for continuous future identification. In the event that it is decided to divide the entire area into zones or strata for separate consideration, a numbering system using a letter prefix for each zone (such as B 437, D 612) would keep the numbers smaller.

For taking the actual samples, a certain amount of special equipment is suggested. The primary requirement would be a motion picture camera with a remote-operated shutter, capable of exposing one frame at a time. The camera should be equipped with a lens capable of taking a picture of a field of 12 by about 15 in., with the subject about three to four feet from the lens. The camera should be mounted pointing downward on a tripod of height equal to the focal length. Legs of the tripod should be spread beyond the field of view of the camera; and they should be equipped with large, free-swivelling casters. Between the legs of the tripod should be mounted a frame about 3 inches by 12 inches, located so that it will appear on the end of the 12 x 15 in. field exposed by the camera. On the frame should be mounted a 12-in. scale or ruler, and an index or counting device which can be remotely operated (Fig. 2).

Attached to each leg of the tripod, down near the casters, should be wire or cable as long as half of the circumference of the containment building to be sampled. Two of these cables are ordinary piano wire or guy wire. The third will contain electrical conductors for remote actuation of the camera shutter and of the counting device mounted on the frame (Fig. 3). The surface of this third cable will be marked at one-foot intervals, and possibly color-coded in 5- or 10-ft intervals.

Next, lay out the area of the entire containment building, using a Mercator projection, conic projection, or other convenient method. Mark off the previously assigned number on each square foot (or at least establish the method for so doing). Then, using a table of random numbers, select the squares to be used as samples. The list of areas to be used as samples should then be tabulated in order as they lie along the longitudinal lines of the containment building, listing the areas nearest the top of the building first.

Having made the above preparations in advance, it is now possible to send out the sampling team into the field. The sampling team should consist of an operator and two helpers. The operator will take the camera and tripod, and the prepared sampling tabulation, to the top of the

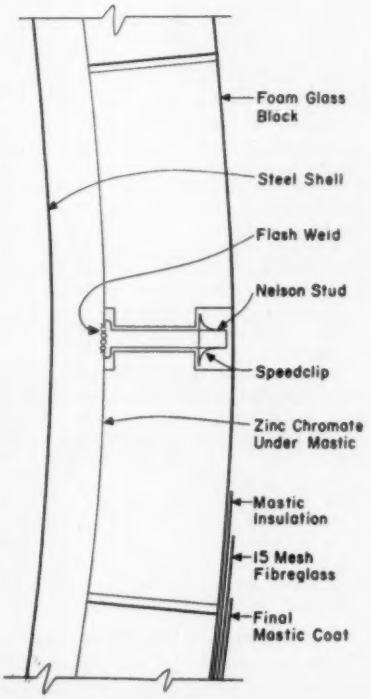


Fig. 1. Cross-section of a portion of the containment shell showing method of applying insulation

* Part I of this article appeared on page 37 of the ATOMICS section in the February 1961 issue of POWER ENGINEERING.

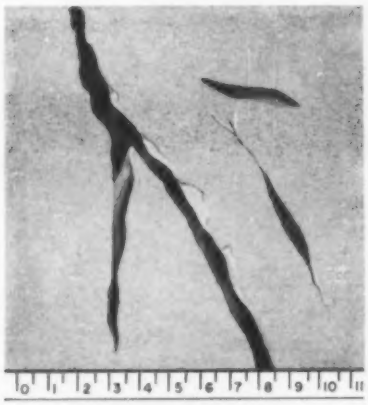


Fig. 2. Drawing of a sample photo shows a view of a 12 by 12-in. section of the insulation

containment building (Note: each building has an access hole at the very top for getting through the shell.) The two helpers remain on the ground outside the building. The operator will lower the two guy wires from the tripod to the helpers on the ground. The helpers are to separate a sufficient distance so as to have adequate lateral control of the tripod (Fig. 3). The operator will then lower the tripod longitudinally down the outside of the building, taking note of the amount of cable he pays out, until he reaches the first area to be sampled. He then actuates the counting device to indicate the number of the square, trips the shutter to photograph the area, and then releases more cable to advance to the next square. When all the required squares on one longitude have been photographed, the tripod is pulled back to the top of the building and the same sequence is followed on the next longitudinal row.

Thus a photograph, with identifying number, is taken of each square to be sampled. These pictures are then developed and printed for evaluation, which is the next step in the operation.

In the event that structural members interfere with proper handling of guy wires, which may happen on the lower hemisphere of a spherical structure (Fig. 3), it may be necessary to take photographs of the inaccessible locations from the ground with a telephoto camera. This should be kept to a minimum, however, since definition on the photo will be poorer, and assurance of photographing the correct sample area is reduced.

Evaluation of the Samples

Evaluation of the samples should be performed by an engineer familiar with the thermal properties of the material. Since each photograph includes a picture of the scale or ruler, the length and width of any cracks in the insulation can be determined. By using aerographic techniques (similar to those used on aerial photography) the depth of the cracks can be estimated. From this information, combined with weather data on the area, and operating data on temperatures in the building, the heat loss for the area of the particular sample square can be calculated.

Need to Repair or Replace

The actual heat loss can be estimated from the sample, within the confidence limits previously established when the size of the sample was determined. Next a calculation must be performed to determine the normal heat loss through insulation assumed to be new, and this loss must be subtracted from the estimated actual loss as determined from the sample. This difference is the heat loss due to faulty insulation, and the annual cost of this loss can be determined from the operating costs of the installation. Finally, a break-even chart must be constructed (Fig. 4).

On the break-even chart, elapsed time in years is plotted on the ordinate. "Zero time" should be taken as the date of initial installation of the containment building, or of the most recent replacement of the insulation. On the abscissa is plotted the cost in dollars of the heat loss due to faulty insulation. Taking a sample annually for several years, at the same time each year, will result in a curve showing the increase in cost of lost heat with time (Curve A, Fig. 4). After the procedure has been followed for, say, five years, the trend of the curve can be established, and the costs extrapolated into the future.

On the same chart should be plotted the cost of repair of the insulation (Curve B, Fig. 4). When determining the cost of this repair, two things must be remembered. First, consider the time value of money, and the appropriate interest rate must be included in this cost. Because of this variable, the "cost of replacement" curve (Curve B, Fig. 4) should be replotted for the present costs whenever the decision is to be made on whether to reinsulate "now" or "later."

Secondly, the cost of reinsulating should be amortized over about the same number of years as the prior insulation has served its purpose or, in the event of a local repair, the cost should be amortized over the estimated life of the repair, in both cases again remembering the time value of money. And, as an obvious final step, when the annual cost of the heat loss due to faulty insulation exceeds the annual amortized cost of repair or replacement (where the curves cross), the repair or replacement should be done at that time.

One important exception to this rule for economic replacement should be noted. The reason for insulating these buildings on the exterior rather than the interior is to avoid extreme temperature gradients across the steel shell. Such extreme gradients when applied cyclically, will reduce the ductility of the shell to a point where the structure might rupture rather than yield when stress or strain was imposed. Engineering determinations of this factor must consequently be made concurrently with the economic analysis. The decision to proceed with repair or replacement of the insulation should be made if either the engineering analysis or the economic break-even evaluation so indicated.

Estimated Cost of Sampling

Cost of taking these samples can be divided into two parts. One part involves the use of capital equipment, and should be amortized over the total number of samples it is estimated will be taken.

Camera with remote shutter	$250.00
Tripod with Casters	75.00
Frame	25.00
Remote digital counter (large)	100.00

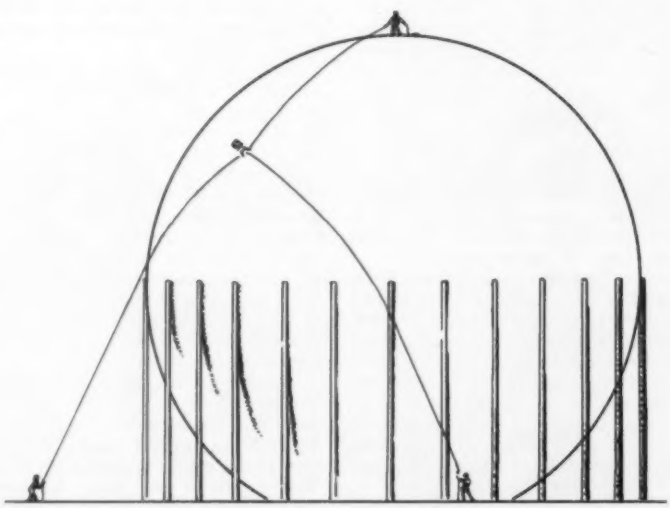


Fig. 3. Drawing showing how a sampling team would take photographs

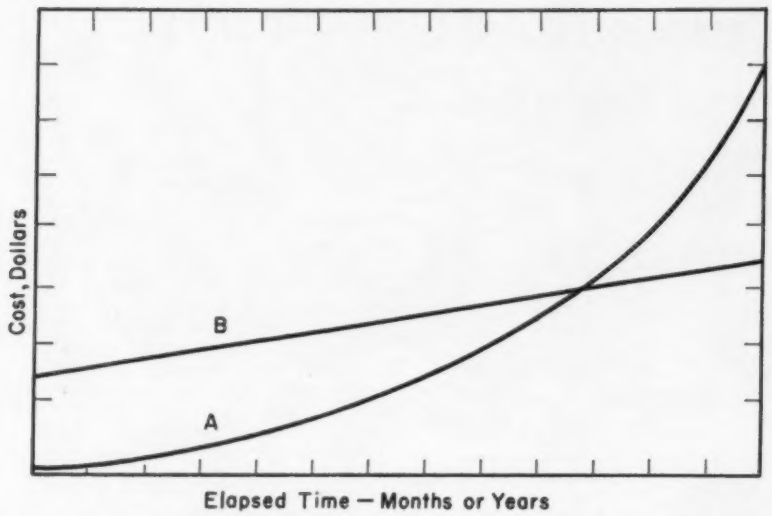


Fig. 4. Typical break-even chart. Curve A, cost of repair or replacement; Curve B, cost of heat loss due to faulty insulation

Guy wire (two 300-ft lengths)...	15.00
Control cable (one 300-ft length).	30.00
Control switches, batteries, etc...	25.00
Labor to assemble (8 hr).....	48.00
	$568.00
Estimate 10 sets of samples will be taken over a 10-year period:	
Annual cost of equipment, to include the time value of money at 6 per cent for 10 years would be $568.00 X 0.136 = $77.25 say $80.00	
Labor to take one set of samples (350 photographs):	
Operator 20 hours at $6.00 per hr.....	$120.00
2 helpers 20 hours at $5.00 per hr.....	$200.00
	$320.00
Engineering 24 hours at $8.00 per hr.....	$192.00
	$512.00
Cost of film, developing and printing exposures at $0.50 each.....	$175.00
Total Cost of Labor and Material	$687.00
Annual Cost of Equipment.....	$ 80.00
	$767.00
Ten per cent contingency.....	$ 77.00
Estimated Total Cost of One Sample.....	$844.00

Actual cost of repair or reinsulation should be obtained by competitive bid. This cost will vary depending on the type and quality of work required, the extent of work, geographic area, urgency (overtime) and other factors. Cost of heat lost due to faulty insulation should be calculated at the lowest possible rate consistent with the actual facts. It should be remembered that the cost per Btu increases with a decrease in total consumption, and in the calculation of the cost of lost heat the lower rate (higher consumption) would be applicable.

The taking of a photographic sample of the total area of a large containment building will result in a statistically accurate measure of the actual condition of the exterior insulation. The method goes beyond the usual attribute sampling, since it not only reveals the number of defects in insulation, but it also reveals the extent of the defects and affords a method of evaluating the economic time for replacement.

Nevertheless, several precautions should be mentioned. First, some difficulty may be encountered by the team operator in positioning the tripod accurately over the square to be photographed. In some cases, depending on curvature, it may be difficult for him or the helpers to see the tripod. A possible refinement here would be to station a signalman with a surveyor's transit some distance from the building, at a point where full visibility of the working area is possible. He could then guide the operator and helpers by hand signals to position the tripod accurately. Another problem may arise in finding a competent aerographer to properly estimate the depth of the cracks appearing in the photographs. The use of a stereo camera, and the addition of a vertical scale or ruler on the tripod frame, would help solve this problem.

It should be noted that this procedure has not been tried as yet, to the best available knowledge of the author. Undoubtedly additional practical problems will arise in the implementing of this procedure; however the basic approach to the problem is economically sound, since it provides a high degree of assurance, at low relative cost, of the economic time to invest a sizable sum of money in a preventive action. THE END

ACKNOWLEDGMENTS

The writer is indebted to G. E. Halm and B. S. Pilling, KAPL, for information on construction and insulation; and to G. L. Burrows, also of KAPL, for his assistance on determination of sample size.

CORRECTION

The author of this article has directed our attention to two errors in the first part of this article on page 38 of the February issue. In equation (1) the proportionality sign $\propto$ should have been used instead of the Greek letters Omega and Eta. In equations (2) and (3) the deviation S_h is squared, but it appears in print as though the subscript is to be squared. Actually the entire term is squared, thus $(S_h)^2$.

Humboldt Bay Aims at 8 Mills per Kwh Power Cost

ACTIVE WORK on the construction of Pacific Gas & Electric Company's Humboldt Bay nuclear power station has been under way since January 23. Ground breaking for the $20.6 million plant, located near Eureka, California, started in mid-November 1960, but major construction did not begin until January 23. The Humboldt Bay Power Plant Nuclear Unit will be California's first full-scale atomic electric generating plant when it goes into operation in the summer of 1962.

This reactor installation is of particular interest for several reasons. First, because the nuclear unit constitutes the third unit in a plant that has had two oil-fired units in operation for a number of years. The two oil-fired units now in operation have a capacity of 100,000 kw. Secondly, the Humboldt Bay nuclear reactor will be the first water-cooled and moderated reactor to use the pressure-suppression method of containment.

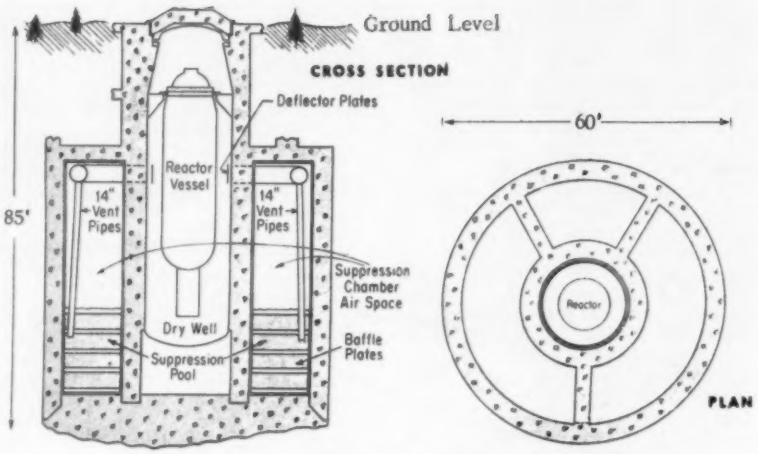
Entirely financed by the Pacific Gas & Electric Company, the nuclear plant has been designed to produce electricity with nuclear fuel at costs that will eventually be competitive with oil fuel at that location. Bechtel Corporation of San Francisco is engineer and prime contractor for the plant, with General Electric Company furnishing the nuclear steam supply system, turbine-generator, and other related electric equipment.

The nuclear unit features an advanced design, single-cycle boiling-water reactor rated at 165,000 kw, thermal, with an initial net electrical output of 50,000 kw. It will be the largest single-cycle natural circulation reactor system ever built. General Electric's Atomic Power Equipment Department at San Jose, Calif., will fabricate and supply 17.3 tons of

uranium dioxide nuclear fuel to PG&E under a separate contract. The fuel will be fabricated into 8428 stainless-steel clad rods and assembled into 172 fuel bundles.

In addition to its simplified natural circulation reactor system, the Humboldt Bay atomic plant will incorporate two technically advanced features — the pressure-suppression reactor containment already mentioned, and internal steam separation. Both of these features contribute to compactness of plant design and reduced capital and maintenance expenses. These features, together with improved nuclear fuels now under development, are expected to make the Humboldt Bay unit this country's first economically competitive nuclear electric plant by 1965–66. At that time, when the reactor gets its second loading of uranium dioxide fuel, the plant is expected to produce electricity at the same cost (about 8 mills per kwh) as that delivered from conventionally fueled plants in the Eureka area.

The pressure-suppression containment system eliminates the need for the large, expensive steel containment sphere which has become the symbol of nuclear power stations. In the pressure-suppression system, the sphere, previously required to trap and hold radioactive fission products in the unlikely event of a system failure, is replaced by a less expensive underground "heat sink" which achieves virtually the same purpose.



Sectional views of Humboldt Bay Reactor Caisson

As shown in the accompanying illustration, the 252-ton reactor pressure vessel — a carbon-steel tank, 40.5 ft high and 10 ft in diameter — will be placed underground in a cylindrical concrete caisson, lined with a steel container called the dry well vessel. The dry well is directly connected by a series of pipes to an adjacent 50,000-cu ft suppression chamber. The caisson, which includes the major components of the pressure-suppression containment system, can be visualized as a giant wheel laid on its side and sunk into the ground.

The wheel's concrete rim is 70 ft deep and four ft thick, with the bottom edge 85 ft below ground level. It is 60 ft in diameter. Three massive concrete spokes, as deep as the rim, connect the rim to a cylindrical concrete hub 27 ft in diameter. Hub walls are also four feet thick, extending the entire 85 ft from ground level to the bottom of the rim.

Inside the hub, which forms the containment system dry well, a $\frac{5}{8}$-in.

IMPORTANT NOTICE

After June 1961 ATOMICS will no longer appear as a section in POWER ENGINEERING. Beginning in July 1961, ATOMICS will appear as a separate magazine, to be published quarterly, in July, October, January, and April. This new publishing plan will greatly expand ATOMICS' coverage of nuclear energy developments, but the new magazine will continue the policy of presenting information about nuclear energy development on a level that can be understood by engineers and others in industry who are not specially trained in nuclear science. ATOMICS will be devoted to all aspects of nuclear science and will cover development in the nuclear field both in the U.S. and abroad.

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thick steel container is installed. The 4½-in.-thick steel reactor vessel is placed inside this assembly. The suppression tank, partly filled with water, is located between the inner wall of the rim and the outer wall of the hub. Forty-eight vent pipes connect the dry well vessel to the suppression tank, ending six feet under water.

The dry well and suppression chamber (heat sink) are designed to function in the event of a failure in the reactor's primary piping system within the dry well. Steam or a steam-water mixture from such a break would be vented directly to the suppression chamber six feet below the water level where it would be quickly and completely condensed, and its energy, as well as any radioactive fission products, would be absorbed by the water.

This system is not only more economical, but its increased safety has been established by a series of exhaustive tests conducted by PG&E and General Electric Co over the past two years.

Another advanced feature of the reactor system at Humboldt Bay will be internal steam separation within the reactor pressure vessel. Internal steam driers remove water from the saturated steam at the top of the reactor pressure vessel and dry it before it flows to the turbine-generator.

In earlier reactor designs, a saturated steam-water mixture is piped to a huge steam drum high over the reactor, where the water is mechanically removed and recirculated to the reactor. The internal steam separation equipment eliminates the elaborate and expensive piping and the high steam drum, thus contributing to the compactness of the plant and reduced construction costs.

Steam generated in the reactor will reach the turbine at 1000 psi and 546 F.

In addition to the two advanced features — pressure-suppression containment and internal steam separation — the natural circulation reactor system to be used at Humboldt Bay itself offers considerable savings on construction and maintenance because of its basic simplicity.

The Humboldt Bay nuclear plant will be California's third atomic electric plant to be placed in operation, and the second joint effort by PG&E and General Electric. The Vallecitos Atomic Power Plant, located near Pleasanton in Almeda County, was the first coöperative venture of the two companies.

California's other operating nuclear power plant is the Atomic Energy Commission's Santa Susanna plant north of Los Angeles. This plant, developed and operated by Atomics International, was placed in operation in 1957, and produces 6000 kw of electric power for distribution by Southern California Edison Co. It is powered by a sodium-graphite reactor. THE END

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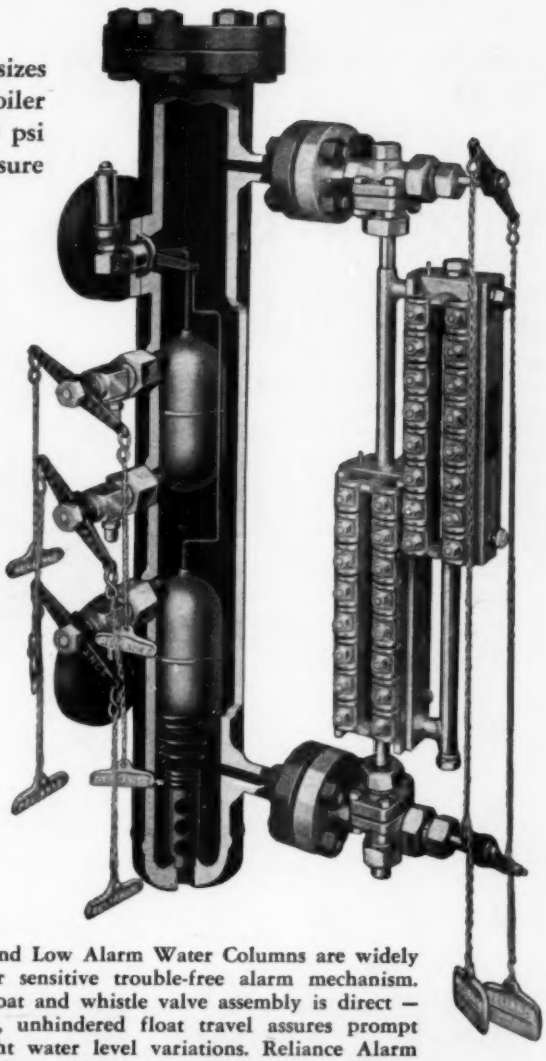

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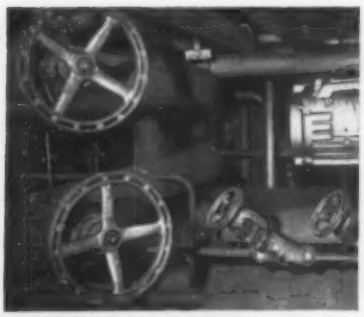
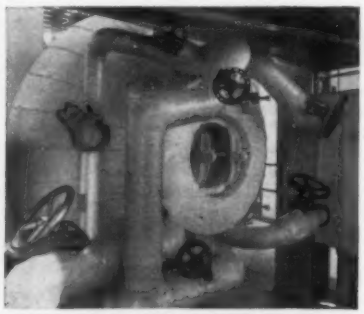


Four of many Yarway Welbonds installed in large eastern public utility plant. Steam pressure 1850 psi; temperature 1000°F.

Four Yarway Welbonds on main steam line to turbine at southern power plant. Press. 2310 psi; temp. 1000°F. Over 100 Welbonds here.



Six of 900 Yarway Welbonds at southwest utility. Boiler drum pressure in this plant—2150 psi; superheat temperature 1005°F.

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SUPERCRITICAL-PRESSURE STEAM TURBINE FOR AVON PLANT

SENIOR ENGINEER NEWTON D. FLACK, CLEVELAND ELECTRIC ILLUMINATING CO,
AND DESIGN ENGINEER JAMES A. MARTIN, OF WESTINGHOUSE,

PROVIDE SOME INSIGHT INTO SUPERCRITICAL DESIGN PROBLEMS

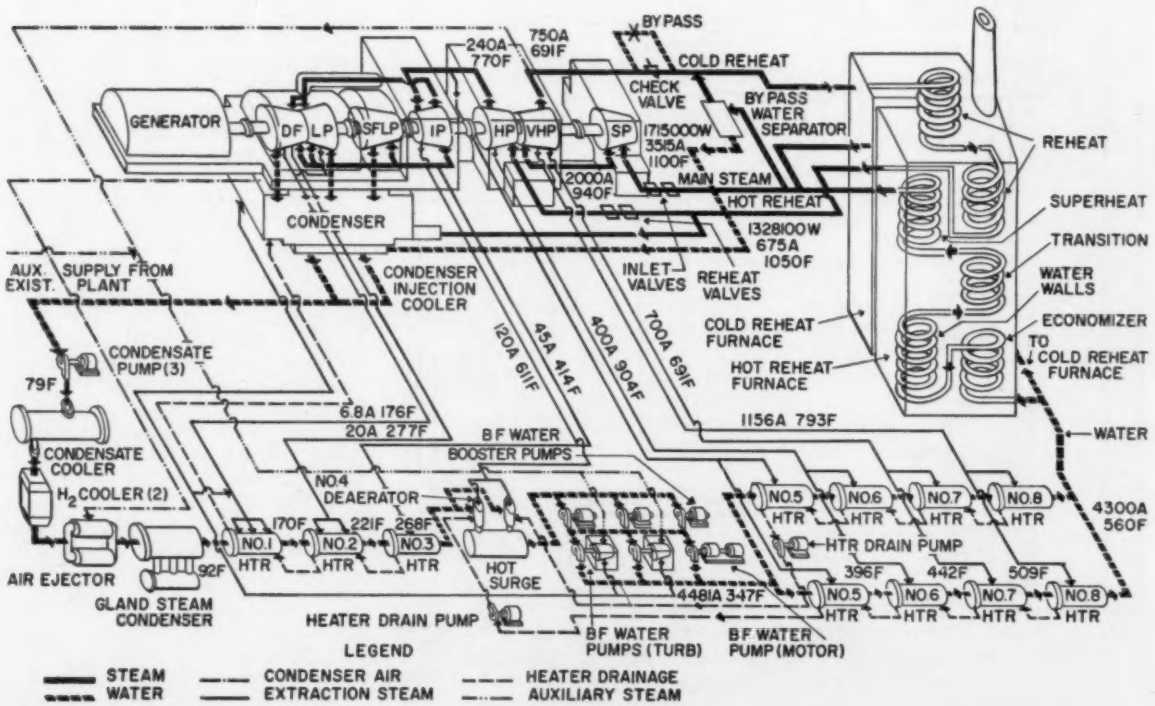
COMMERCIAL operation of the nation's third supercritical pressure generating unit was initiated by the Cleveland Electric Illuminating Company in December, 1959. This addition to the Avon Lake Plant has a nameplate rating of 215,000 kw and a maximum rating of 250,000 kw. It raised the gross capability of the plant to 670,000 kw and of the total system to 2,269,000 kw.

Designed for 3500 psig and 1100 F main inlet pressure and temperature, 1050 F reheat temperature, and one inch of mercury absolute exhaust pressure, the steam turbine is a Westinghouse tandem compound, single reheat, impulse-reaction, triple-flow exhaust machine. The hydrogen inner-cooled generator is rated 273,640 kva at 22 kv, 0.85 power factor and 45 psig hydrogen pressure, with an operating capability of 297,419 kva at 60 psig.

Fig. 1. Simplified flow diagram showing steam, condensate, and feedwater conditions for maximum load of 250 Mw. The auxiliary supply from the existing plant to the turbine feed pumps is also shown

Thermal Cycle

Steam path is shown in Figure 1, with conditions given for the maximum load of 250 Mw; flow entering

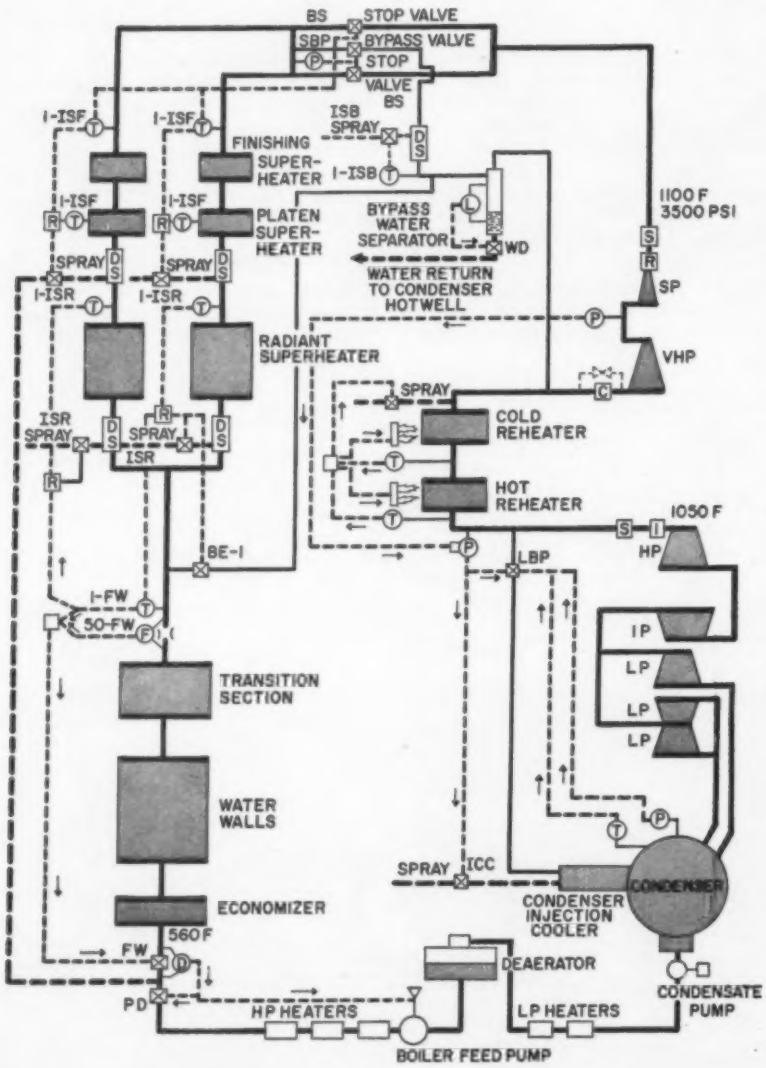


the main stop valves is 1,715,000 pounds per hour at this load. Four high-pressure heaters, one deaerating heater and three low-pressure heaters are used to heat the feedwater to 560 F as it enters the boiler. There are two parallel strings of high-pressure heaters, a single string of low-pressure heaters and twin deaerating heaters with a common hot-surge tank.

Three half-capacity boiler feed pumps connected in parallel are located between the deaerating fourth heater and fifth heaters. One pump is driven by two 4000-hp motors in tandem and is used for normal operation as well as for start-up service. The other two pumps have turbine drives which extract steam from the cold reheat zone of the cycle and exhaust to the lowest-pressure heater. During normal operation any combination of two boiler feed pumps can be used.

Upon leaving the monotube steam generator, the steam flows through four sets of main-stop and control valves into the superpressure (SP) component and then through the very high pressure (VHP) element of the very high pressure-high pressure (VHP-HP) component. The steam is then reheated and returned through two reheat stop valves and four interceptor valves to the high-pressure (HP) element. The steam then flows through the intermediate pressure (IP) element after which approximately one-third of the steam passes through the opposed single-flow low-pressure (SFLP) blading of the IP component with the remaining two-thirds passing through the double-flow low-pressure (DFLP) component. The steam then exhausts through the triple turbine exhausts into the condenser.

Fig. 2. Schematic flow diagram of CE-Sulzer Monotube unit in single-reheat cycle



By-Pass System

Elevated steam conditions of this unit necessitated innovations in turbine design as well as in the design of other associated equipment. The Combustion Engineering-Sulzer Monotube, or once-through boiler, having no drum or recirculation system, incorporates a by-pass system which provides circulation through the boiler during start-up and permits establishing steam pressure and temperature before starting the turbine. It also provides a means of protecting the turbine from high temperature and pressure during normal operation.

This by-pass system, as shown in Figure 2, has a normal flow equal to 30 per cent of maximum flow, and it permits by-passing steam around the turbine elements. During cold starting with the boiler feed pumps establishing circulation through the boiler, the boiler stop (BS) valves are closed and the superpressure by-pass (SBP) valves are opened to admit water to the by-pass water separator. The water drains out of the separator through the water discharge (WD) valve directly to the condenser.

As the firing rate is increased, steam flashing will occur in the water separator in increasing quantities. This steam portion flows through the reheater, by-passing the SP and VHP elements, and then continues through the low-pressure by-pass (LBP) valves to the condenser injection cooler, by-passing the HP, IP, and LP elements. The condenser injection cooler (steam killer) reduces the steam temperature and pressure to conditions acceptable to the main condenser.

By maintaining the 30 per cent minimum flow and increasing coal firing, the steam is brought up to proper temperature and pressure in the by-pass system before starting the turbine. The steam is then transferred to the turbine through both the main inlet turbine valves and the reheat inlet turbine valves. Thus the interceptor valves as well as the main governor valves must act as control valves until the entire by-pass steam flow is transferred to the turbine.

During cold starting, the by-pass system is used to advantage to preheat the VHP and SP elements by

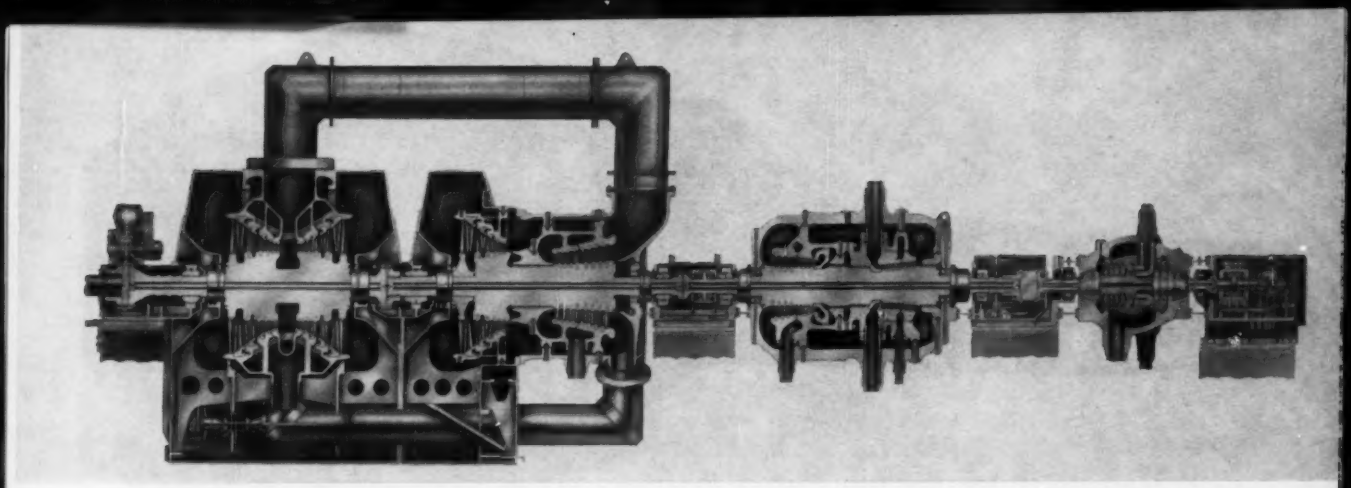


Fig. 3. Longitudinal cross-section of the steam turbine, a tandem-compound, single-reheat, triple-flow exhaust machine

admitting steam around the cold reheat check valve to the VHP-element exhaust zone.

Turbine Components

Figure 3 is a longitudinal cross section through the vertical centerline of the superpressure, very high pressure–high pressure, intermediate and low-pressure components. Of interest from a size viewpoint is the fact that blade heights increase from 1.05 inches at the inlet to 25 inches at the exhaust end. This provides for a terminal volumetric flow ratio of approximately 1600 to 1.

Most of the innovations in turbine design are concerned with the main steam inlet valving and piping and the SP element. The exceptionally high steam pressure and temperature are confined to the SP element in which the steam is expanded to 2000 psia and 940 F while producing 30,000 kw or 12 per cent of the unit's maximum output. The other turbine components are therefore essentially conventional in design.

Figure 4 illustrates the turbine main steam inlet piping and SP element arrangement of four sets of close-coupled main-stop and control valves, four flexible main-turbine leads, and the spherically-shaped SP casing. The inlet-valving arrangement varies considerably from the conventional Westinghouse throttle valve and steam chest arrangement. These valves are anchored by steel supports or "sleds" designed to rigidly fix the control valve within the sled while providing for thermal expansion movement in a horizontal plane of the stop valve with respect to the control valve.

The four main control valves open

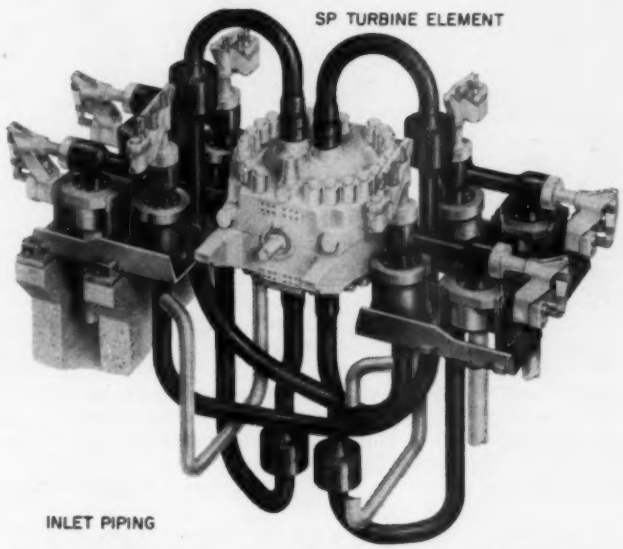


Fig. 4. Spherically shaped superpressure casing with main steam inlet piping and close-couple main-stop and control valves

and close in unison to provide the first stage with steam admission over the full 360-degree arc at all loads. Main inlet pipes are also connected by jumper lines to assure 360-degree admission during full closure testing of the individual stop and control valves under any load. Partial steam admission operation (sequentially operated valves) was discarded early in the design phase to avoid excessive deflection of the relatively light SP rotor and high blade-shock loading.

Turbine inlet valve, inlet piping, SP-element inner and outer casings, and nozzle chambers are all of ferritic steel (2¼ per cent Cr, 1 per cent Mo, ¼ per cent V) composition. The SP rotor is forged of 1 per cent Cr, 1¼ per cent Mo, ½ per cent Ni, ¼ per cent Van alloy steel.

Superpressure blading consists of a single Curtis or velocity-compounded stage and four Rateau (impulse) stages. The Curtis stage produces a maximum of work while lowering the steam temperature entering the Rateau blading to 1040 F. The exhaust of the SP element passes through the space between the inner and outer casing, minimizing the pressure drop across the inner casing and cooling the internal surface of the outer casing. Cooling is accomplished by locating auxiliary exhausts in both the base and cover of the element at the governor end.

Sealing the SP Element

To seal the SP element against high-pressure steam leaking out along the shaft, a new nested-type radial seal design developed by the Siemens Schuckert Company was used. This type of sealing arrangement, shown in Figure 6, provides a great number of pressure breakdown labyrinth seals in a relatively short axial length. The rotating discs and stationary rings of this seal are assembled on the rotor

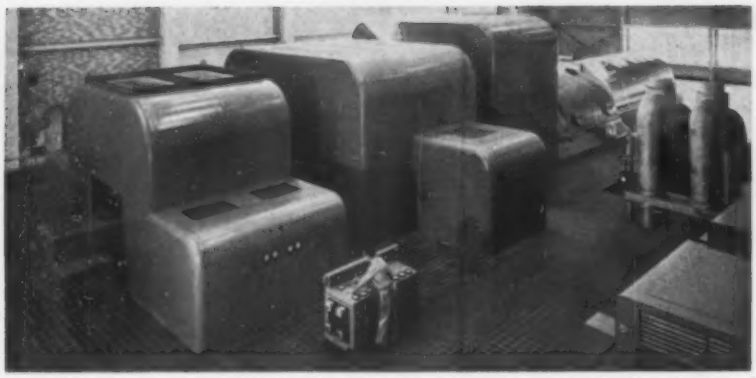


Fig. 5. Fully lagged supercritical pressure generating unit installed at Avon

shaft before the rotor is placed in the turbine casing. The rotating discs are fixed to the rotor by a shrink fit and then doweled.

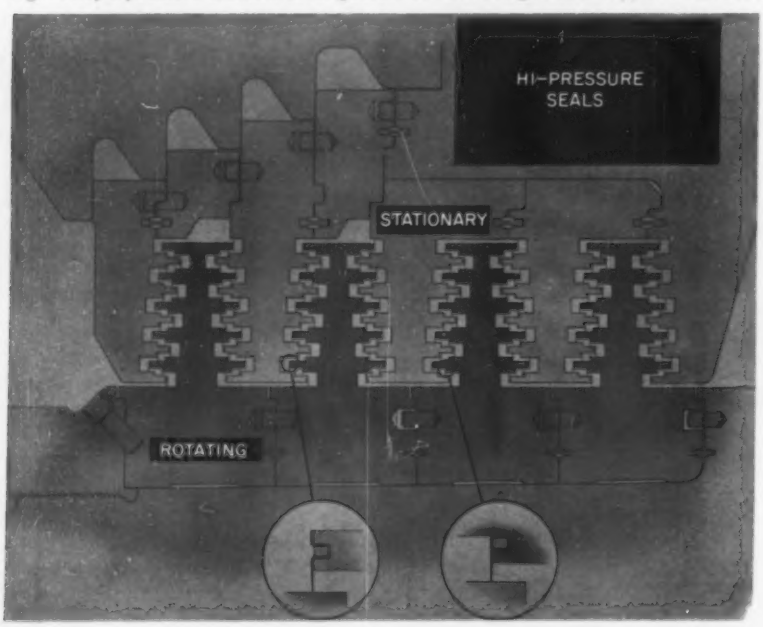
Reheat inlet arrangement consists of two sets of reheat stop valve-interceptor valve combinations such that each reheat stop valve is connected through two long flexible pipes to two interceptor valves. The reheat stop valves, one located on each side of the VHP-HP component, are supported by "sleds" similar to those supporting the main-stop and control valves. The interceptor valves are mounted directly on the VHP-HP casing, two on the cover and two on the base. The HP nozzle chamber consists of four cast-steel sections interconnected through openings at their joints to assure uniform circumferential admission of steam.

Innovations in the turbine-pedestal and shaft-coupling designs were required because of the arrangement of four separate in-line components and the resultant high magnitude of cylinder expansions and differential expansions between the rotors and cylinders. The SP rotor is designed with a balance piston to balance the blading thrust and has its own Kingsbury-type thrust bearing located in the governor pedestal at the inlet end.

The VHP-HP and the IP blade paths and balance pistons are designed to result in a combined balance thrust. A Kingsbury-type thrust bearing is located at the inboard thrust pedestal between the VHP-HP and IP components for axially positioning the VHP-HP, IP, and DFLP rotors.

Turbine is anchored to the foundation at the transverse centerline of the low-pressure exhaust. Thus, the cylinders expand toward the governor end when heated by the steam flow. To accommodate an accumulative cylinder expansion of approximately 1½ inches, the inboard pedestal located between the SP and VHP-HP components is constructed with the VHP-HP half free to slide while the SP element half is anchored to the foundation.

Fig. 6. Superpressure element arrangement of new design nested-type radial seal



Differential Expansion

Differential expansion between the SP and VHP-IP rotors is accommodated by a new-design flexible-type coupling with a built-in continuous lubrication system. A coupling hub with external spur gear teeth is mounted on the end of each shaft. Two floating coupling sleeves with internal spur gears are connected by a spacer and mesh with each hub. Thus, as the gap between the two shafts changes due to expansion, the mating spur gear teeth slide axially in relation to each other while maintaining a fast tie in the plane of rotation.

The coupling was dynamically balanced in the Westinghouse shops before field installation and has been performing satisfactorily with vibration amplitudes within design allowables. Conventional flanged rigid-type couplings connect the VHP-HP, IP, DFLP and generator shafts to one another.

Steam-sealed gland system is equipped with a controller to maintain proper pressure balance and a desuperheater to insure low-temperature steam to the exhaust-end glands. A gland condenser equipped with exhauster fans draws the leakoff steam and air from the gland seals, condenses the steam, and discharges the air to the atmosphere. The condensed steam is returned to the main condenser.

Turbine Control System

A hydraulic control system, new in concept, having a 300-psi main operating oil pump pressure was used. The unit's high operating steam pressures and numerous hydraulic servomotors dictated this high-pressure oil system in order to keep the turbine-valve servo-motors of reasonable size and the oil system capacity within that of existing systems. THE END

Construction of cribhouse well is nearing completion. Work on superstructure for fifth generating unit is also progressing at this site on the Ohio River, 20 miles east of Cincinnati. Generating capacity on completion: 1,500,000 kw

Superstructure for fifth generating unit rises next to cribhouse (arrow)

SMOKELESS STACK RISES FROM RIVER

BIGGEST STACK in the area will rise from the Ohio River as part of the new $47,000,000 electric generating unit at the Walter C. Beckjord Station of the Cincinnati Gas & Electric Company.

Designed by Sargent & Lundy, this mammoth structure, rising 515 feet in the air, will be supported atop a massive concrete and steel cribhouse. The base of the stack will house water treatment and fly ash control equipment for the new fifth, and future sixth, generating units. From the top of the $1,000,000 stack will emanate only a hazy steam-like wisp.

Engineers of CG&E are employing the sand island method to sink the 3609-ton cribhouse through 60 feet of sand to bedrock.

According to Ernest S. Fields, CG&E president, the 250,000-kilowatt fifth generator should be completed in the fall of 1962. The sixth unit will be added at a later date when the need arises.

Harbor and coal-handling facilities at Beckjord Station will be enlarged at a cost of $2,000,000. Jumbo barges will be used to carry 1500 tons instead of standard 1000-ton barges which are now in service. A new coal tipple will be designed to unload 1000 tons per hour as compared to the 600 ton per hour capacity of the present tipple.

Installation of the fifth unit will increase the capacity of Beckjord Station to 765,000 kw and will increase coal consumption from an average 4000 tons per day to 6000 tons per day.

When the sixth unit is completed, use of coal will increase to 8000 tons or more per day. THE END

Executive Committee, l to r: Jack Hilt, Grant Bloodgood, J. Barry Cook, Gerald McCarthy, F. B. Slichter, F. S. Brown, A. E. Eckberg

USCOLD MEETS IN ROME IN JUNE

U.S. TO PRESENT 23 PAPERS AT ROME MEETING OF THE INTERNATIONAL COMMISSION ON LARGE DAMS JUNE 25-JULY 1

EVERY third year ICOLD, the International Commission on Large Dams, holds an international meeting. The Seventh Congress will be held in Rome from June 25 to July 1 and will be followed by four study tours running simultaneously from July 1–9. Registrants will have a choice of Northwest, Northeast, Central or Southern Italy.

ICOLD and USCOLD, the United States Committee on Large Dams, are both affiliated with the World Power Conference. Four questions selected by the Executive Committee are treated in detail at each Congress by the reporter method. All papers on each question are summarized by a general reporter. At the sessions his summary is presented and followed by written and oral discussion, as time permits. The questions at the June Congress, numbered consecutively from the First Congress, are:

No. 24. Selection, processing and specification of aggregates for concrete for large dams. (Large dam by definition of the organization is 50 ft or over.)

No. 25. Underground work in connection with large dams.

No. 26. Modern techniques for concrete dams and ancillary works for wide valleys.

No. 27. Sealing of earth and rock-fill dams with bitumen and other materials.

Through the activities of the Technical Activities Committee, George Palo, chairman, and the Reviewing Committee, Louis Puls, chairman, many papers were submitted and 23 representing 33 authors were accepted. Two Federal and one State agency plus four engineering companies are represented by the authors. George Bertram, general reporter for Question No. 27, received for translation and summarization, 21 papers from 12 countries, including three from the U.S. U.S. entries for the other three questions were 5, 5 and 8, respectively.

At the Denver meeting a number of changes were made in the organizational setup occasioned by the retirement of General Reimel, long-time secretary-treasurer. A contract was subsequently signed with the Engineers Joint Council to take care of all routine correspondence, records, membership directories, billing members and paying bills, assistance with secretarial work, preparation of the annual and financial reports. The services include a bonded treasurer and assistant secretary-treasurer.

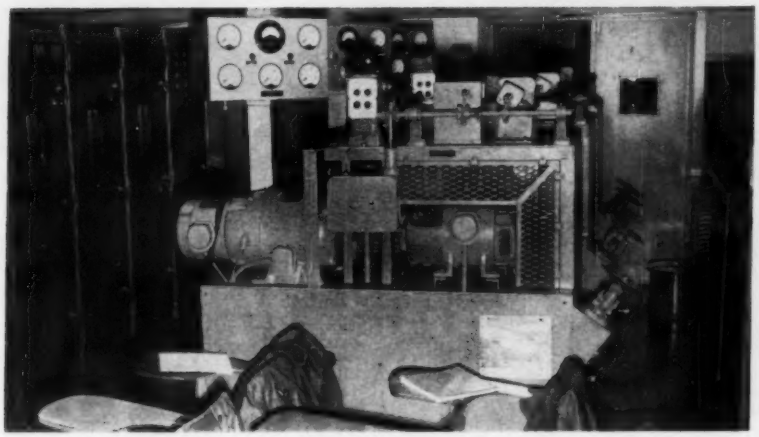
A similar arrangement was made by the U.S. Committee of the World Power Conference involving $3000 annually from each organization. Chairman McCarthy's term runs through another year, and to fill in the slate of officers, Francis Slichter was elected vice-chairman and Wilson Binger, secretary. McCarthy, Slichter, Ted Mermel and F. S. Brown were elected to the Executive Committee earlier by mail ballot.

Further details of the program and registration blanks for the meetings can be obtained from USCOLD, Engineers Joint Council, 29 West 39th Street, New York 18, N.Y. This headquarters also has available a few copies of the Transactions of the Sixth Congress held in New York in 1958.

Membership in USCOLD is on either an individual or organization basis to those of established professional competence interested in the design, construction, operation or maintenance of large dams and elected by the Executive Committee. Individual membership is $10 annually. Further details and application forms can be obtained from the headquarters office or from the Membership Committee: Chairman, E. R. deLuccia, 309 S. W. Skyline Drive, Oswego, Ore.; F. B. Slichter, Box Hill Farm, Route No. 1, Box 101, Burke, Va.; or Dick Morris, Editorial Director of POWER ENGINEERING, 308 E. James St., Barrington, Ill. THE END

UNIQUE DEVICE SPEEDS TRAINING OF DIESEL OPERATORS

CAPTAIN HENRY POOS DESCRIBES CLASSROOM OPERATIONS SIMULATOR USED BY AIR FORCE



U.S. AIR FORCE has over 1800 diesel electric generators in 473 locations throughout the world. These plants are needed because of isolated sites and/or critical power requirements for sensitive electronic equipment. The plants are operated and maintained by Air Force personnel. The Air Force conducts training of these personnel at Sheppard Air Force Base, Wichita Falls, Texas.

In addition to 60 pieces of installed operational equipment ranging in size from 100- to 650-kw plants and typical of Air Force power plants, there are five unique simulator trainers. These trainers were designed and fabricated by the Air Force and represent a powerhouse in which three 600-kw diesel electric generators are installed.

Each simulator trainer is installed in a room 20 by 30 ft. Primary and secondary switchgear are actual equipment complete with synchronizing panel; however, instrumentation, transformers, and circuit breakers are modified to respond to 208 volts instead of the 2400 or 4160 volts found usually in a powerhouse.

The simulator has three separate prime movers to simulate the diesel engine and generator. Each prime mover has a 5-hp d-c 230-v shunt wound motor which powers the 3-kw 208/120-v 4-wire 3-phase 60-cycle generator, including a direct-connected overhung exciter, field rheostat, and field discharge resistor.

Speed of the motor generator is controlled by an electronic excited variable speed drive which is signaled by electronic and mechanical linkage from a Woodward Model UG-8 hydraulic governor. The operator controls the governor by remote control as he would in a powerhouse.

Instrumentation for the simulated prime mover includes, in addition to the governor, a fuel pressure control group, overspeed stop group, globe valve start group (turning the globe valve actuates a microswitch which starts the variable speed drive), a 6-position pyrometer, a temperature control group, and the following gages — water pressure, fuel oil pressure, turbocharger oil pressure, water pressure, and air pressure.

Program Control

The trainer is controlled by an electronic programmer which is capable of automatically providing a planned program for periods as long as two hours. This is accomplished by use of punched cards automatically fed into an electronic card reader. A photoelectric matrix "reads out" the information and transmits it to the associated programmer which produces situations requiring action on the part of the student.

The programmer provides power distribution, timing pulses, temperature and pressure programming actions. This may be an increased load which requires the student to start another simulated prime mover, synchronize it and connect it to the main bus, or it may require a response to an alarm sounded by the annunciator.

An example of an alarm situation may be a simulated low oil pressure. Pressure is programmed to drop to 20 pounds, at which time the alarm sounds. The student has two of the three units on the bus and the load is beyond the capacity of a single unit. He has five minutes to start the third unit, synchronize it and connect it to the bus, disconnect the faulty unit from the bus and shut it down. If he does not accomplish this, his lubricating oil pressure falls to 15 pounds and the unit automatically shuts down.

If he has not connected the third unit to the bus, the load is beyond the capacity of one unit and automatically shuts down due to overload. The student has lost everything, yet the equipment is undamaged. Any number of simulated situations can be created that would otherwise be impractical on actual equipment.

Other features of the trainer include load division and operation with speed drop settings. A tape recording is built into the trainer to provide a realistic powerhouse environment if desired.

Advantages

Advantages of the simulator trainer are many. Cost is little more than one-third the cost of actual powerhouse equipment, and the unit requires about one-fourth the space, a big saving. Cost of operation is 20 cents per hour compared with $20 per hour on actual equipment. This figure does not include maintenance. Maintenance cost is estimated at about one-fifth that of actual equipment. Noise level is low, permitting instruction to be conducted at normal voice level. The simulator trainer requires a very short warm-up period, which results in a great saving of training time.

Trainees receive 19 weeks of intensive instruction on the operation and maintenance of diesel electric generators prior to a field assignment. Follow-up evaluations indicate they can do an excellent job within a short time. On many remote sites, an airman 18 or 19 years old operates the plant on shift by himself and seldom encounters power failure. The plant is managed by experienced NCO; however, due to shortage of personnel and other duties, he must depend on the lower-grade airmen for sustained operation. This proves once again that our American boys can adapt quickly and give a good account of themselves. THE END

THE WATER SUPPLY PROBLEM

DESALTING OF SALINE WATER IS ONE ANSWER WITH A BRIGHT FUTURE, AND AN ATTRACTIVE ENERGY SOURCE FOR THIS PROCESS IS LOW GRADE HEAT FROM STEAM ELECTRIC PLANTS

THESE PLANTS ARE PRODUCING STEAM AND FRESH WATER

FACTS, figures, predictions and reports bearing on the nation's fresh water supply are rapidly accumulating. They vary in impression from scare-shortage of water supply to the more sober judgment that pollution, not scarcity of supply, is the nation's No. 1 water problem. But the general fact seems well established that we do indeed have an over-all problem of adequate fresh water supply facing our national life.

While the statistics about it are often confusing, nothing could be more logical than the nature of the problem — more people need more water. In 1900, with population around 90 million, the average daily water consumption per American for household use was less than 95 gallons. Today, with population exceeding the 180 million mark, we individually use an average of 150 gpd for domestic purposes. On top of this is a staggering demand for agriculture and for our complex industrial activity.

What does this mean in terms of supply?

The U.S. Geological Survey places the nation's total of readily available fresh water supply at about 515 billion gpd. We are already said to be using 60 per cent of this total. By 1975, the figure is expected to jump to 88 per cent, and more and more areas will face restricted development due to insufficient water.

Or take the picture as seen through the eyes of the research organization, Resources for the Future. In a recent special study, RFF states that total withdrawals of water by the country as a whole may nearly double between 1954 and 1980, and triple by the year 2000.

1 2 3

1 MORRO BAY—$2.50/1000 GALLONS COULD BE $1.20

FIRST land-based sea water evaporator plant in the U.S. was built on the California coast to serve the first two 165,000-kw generating units of the Morro Bay Power Plant of the Pacific Gas & Electric Co. Located in San Luis Obispo County, this evaporator installation is of the submerged tube type and has been operating since 1955–56. A three-effect evaporator set made by Lummus was selected as being best for the prevailing conditions at the time — one set for each generating unit. Figure 2 shows the Morro Bay system. As described by Albert W. Bruce, PG & E's supervising mechanical engineer on the project:

Steam for the submerged heating tubes of the first effect is supplied from the high purity evaporator which is supplied from the fourth extraction point of the main turbine. Distilled vapor from the sea water in the first effect shell supplies the second effect tubes and in turn the second effect vapor supplies the third effect tubes. Vapor from the third effect is condensed in the evaporator condenser which is cooled by sea water.

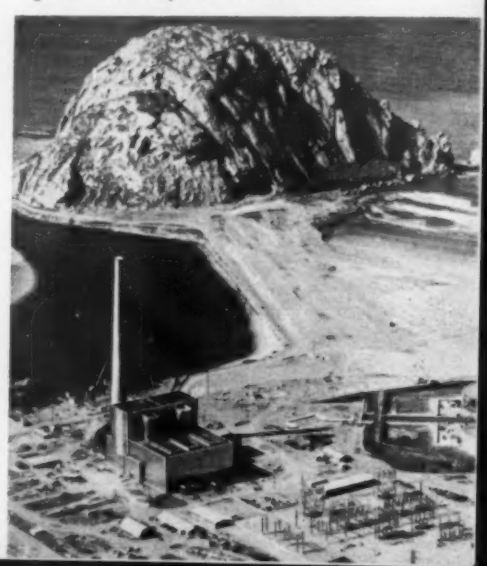
Part of this sea water, which is heated in the condenser, becomes the feed to the evaporators and cascades from the first effect shell to the second effect and then to the third effect shell. It is then pumped from the third effect shell to the main circulating water outlet pipe. The sea water has about 36,000 ppm of dissolved solids which are concentrated to 1½ times or 54,000 ppm on discharge from the last effect.

Vacuum in the evaporator condenser is maintained by a steam jet air ejector, whose condensers are cooled by the distillate from the evaporator condenser. Condensate from the first effect tubes is returned to the feedwater cycle by discharge to the main station condenser through a drain cooler which heats the sea water supply to the first effect.

Distillate from the second effect tubes is flashed in a flash tank, the vapor going to the third effect tubes and the water to the evaporator condenser. Distillate from the latter is pumped through the air ejector condensing tubes, part of it feeding the station evaporator, and the remainder going to the raw water storage tank. Each evaporator effect is vented at the front and rear of the shell. The vents are evacuated to the evaporator condenser. It is important that the oxygen and carbon dioxide be vented to reduce the shell corrosion.

For the first two 165,000-kw generating units in the plant, it was determined that a fresh water supply for all purposes should be 100 gpm.

Fig. 1. Morro Bay Power Plant in Calif.



Actual losses of water from gross withdrawals also would rise but not nearly so fast (it must always be remembered that water "use" does not mean in every case that the water is "lost").

However, RFF says that when expected increases in on-site uses are added to net withdrawals, the total losses chargeable against run-off would rise just about as fast as gross withdrawals, from 109 bgd in 1954 to around 190 billion in 1980 and over 250 billion in 2000.

On top of this must come the additional supplies needed for waste dilution. RFF foresees that, with the most efficient degrees of treatment, 210 bgd might be needed for dilution by 1980 and 360 billion by 2000. At present levels of waste treatment, the nation-wide demand for dilution might even by 1980 be as large as the total flow available for all purposes.

RFF concludes that to provide sustained flows of these amounts, 315 million acre-feet of additional storage capacity would be required by 1980, and 442 million acre-feet by 2000, as compared with total storage capacity of about 278 million acre-feet for all purposes in the U.S. in 1954.

What is Being Done?

What is being done to cope with the growing problem? Fortunately, there is an aroused awareness, expressing itself on three fronts:

1. *Research* by Federal, state and municipal governments, directed at charting courses of underground rivers,

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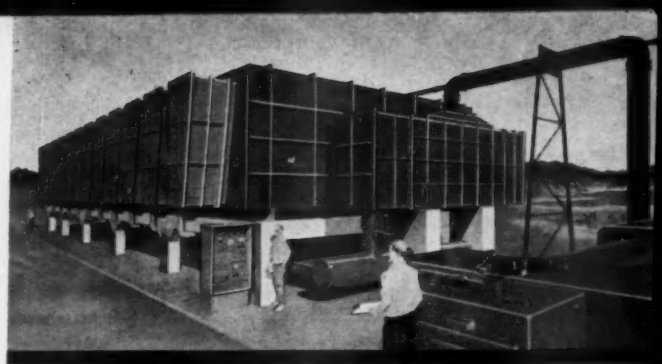
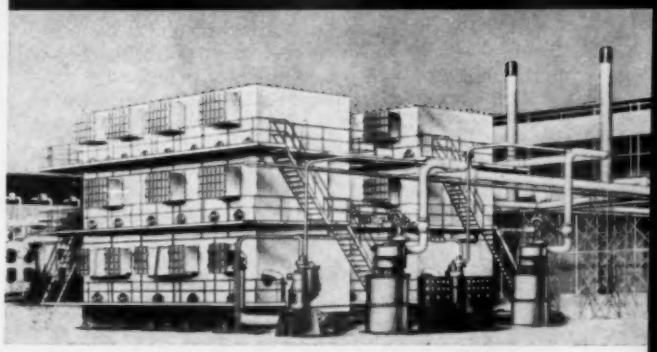




Above: Designers at Cleaver-Brooks Special Products picture their concept of what a 1 million-gpd water distilling plant might look like. Lower: artist's conception of Weir multiflash sea water evaporation plant being erected in Kuwait to provide 2,250,000 gal per day of fresh water

Therefore each of the two sea water evaporator sets was specified to produce 50 gpm of distillate at a purity of 50 ppm of dissolved solids.

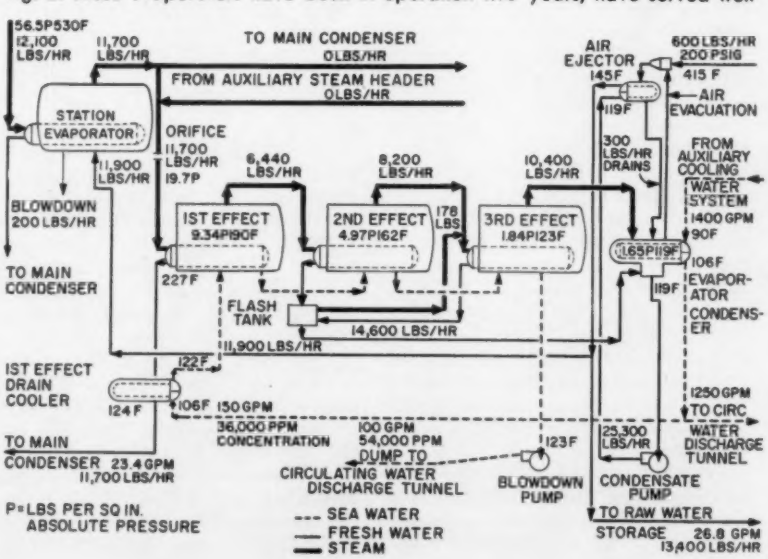
About half of the distillate is required for boiler make-up and is redistilled in the station evaporator to a purity of 0.5 ppm or less of dissolved solids. Remainder of the distillate is pumped to a 500,000-gal standpipe located on the bluff above the plant. This water mixed with the water pumped from the wells on the property is used for general utility purposes.

Experience with operation of the evaporators at designed conditions of 19.7 psi absolute, 228 F steam supply and 190 F first stage brine temperature, indicates that tube cleanliness cannot be maintained for prolonged periods without some form of feedwater treatment. Operation also indicates that scale control is improved when the tube metal in contact with the brine is maintained at temperatures below 190 F. This gives 172 F temperatures in the sea water brine. Output is reduced to about 80 per cent under these conditions.

These sea water evaporators, selected in 1953, have served well, PG & E states, but points out that there are now available newer developments which should make the cost of fresh water less. It is estimated that the cost of the fresh water from the present Morro Bay units, if they are operated at full capacity for the whole year (which has not been necessary), would be $2.50 per 1000 gal when fuel cost is 35 cents per million Btu ($2.24 per barrel of 6,400,000 Btu fuel oil).

For the newer, flash type of evaporator, with steam supplied from the next to last extraction point of the turbine, with zero psi gage and 212 F at maximum rating, PG & E estimates that the cost of fresh water would be $1.20 per 1000 gal at 100 per cent capacity with 35 cents per million Btu fuel.

Fig. 2. These evaporators have been in operation five years, have served well



studying plant transpiration, cloud seeding, water losses caused by evaporation, seepage and eroded land surfaces and similar aspects.

2. *Pollution abatement* and reclamation of sewage effluent.

3. *Desalting water* from the sea and brackish sources.

Let's take a close look at the situation today in respect to the No. 3 area — converting salt water to fresh.

Leadership by the Federal Government in the campaign for action on the water supply problem has resulted, among other important steps, in the establishment of the Office of Saline Water. Set up in 1952 under the Dept of the Interior, its job is to develop practicable, low-cost means of producing from sea water, water of a quality suitable for agriculture, industrial, municipal, and other beneficial consumptive uses. Director of this program is now Charles Frederic MacGowan of Kansas City.

In 1958, Congress authorized $10 million to provide for the construction and operation of five saline water conversion plants which would test the potentials of the most promising conversion processes. When the Office of Saline Water began its work in 1952, $5 per 1000 gallons of water was generally used as the cost of sea water conversion. Today, three of the five demonstration plants are expected to purify water for $1 per 1000 gallons, and OSW engineers talk hopefully of 40-cent water in a few years. The accompanying table gives a quick résumé of the present status of these five demonstration plants.

THESE PLANTS ARE PRODUCING STEAM AND FRESH WATER

Distillation Most Promising

Among the various methods for converting salt water to fresh, today the most advanced commercially is distillation. This is the process by which water vapor or steam is produced from the sea water, the condensed vapor being the fresh water product. Under this general method come the following variations:

1. Multiple effect submerged tube evaporation, each evaporator containing tube bundles submerged in sea water, steam or water vapor inside the tubes causing the sea water to boil; 2. multiple effect flash distillation, the temperature of the incoming sea water being raised by piping it through successive flash chambers, accomplishing flashing of brine into steam; 3. long tube vertical multiple effect distillation with nest of tubes 20 to 35 ft long in an evaporator shell, sea water entering tubes at bottom and beginning to boil part way up in the tubes, while steam condenses outside the tubes; 4. vapor compression distillation, in which the latent heat of evaporation is continually reused by compression of the vapor;

1 2 3

2 MANDALAY—$1.92/1000 GALLONS TO LESS THAN $1

IN DECEMBER, 1959, Southern California Edison Co began operation of a 100,000-gpd water distilling pilot plant to supply the fresh water needed at its steam electric plant at Mandalay Beach near Oxnard, Cal. The 26-stage evaporator, by Cleaver-Brooks Special Products, is of the long tube flash type, uses turbine extraction steam, produces high purity water, and has been specially instrumented for a 3-year research program.

Commenting on various aspects of this installation, Gordon F. Leitner, vice-president of Cleaver-Brooks Special Products, says:

Steam from the fifth point extraction of a modern turbine provides a heat source at a minimum temperature of 235 F upstream of the pressure reducing and desuperheating station. This heat source is of the same level as that employed in most existing large-scale distilling plants, and, therefore, its application to such a process is based on substantial experience.

In the flash-type plant operating in conjunction with a steam power plant, three basic systems merit consideration. The once-through cycle, in which the sea water passes through the condensers, the salt water heater and then the flash chambers, has been used extensively on marine and some land-based plants. It has certain advantages in that with normal sea water and within certain temperature limits, operating periods of twelve months and longer without cleaning and without chemical feed treatment are possible.

A second system which merits consideration is use of warm condenser water. In this system, the condenser water from the power plant is introduced into the flash chambers, and after flashing is pumped out and discharged. The flashed vapors are condensed on the distilling plant condensers by a separate flow of cold sea water. This, in effect, is also a "once-through" system.

The third system is that using brine recirculation. Here the brine, after having passed through the evaporator flash chambers instead of being discharged to waste, is returned to the condenser section at a higher pressure stage, and recycled through the system. Brine concentration is maintained at the desired level by continuous blowdown. Sea water makeup is added to the system at a convenient point where it is also deaerated. Additional cooling water is required in the condensers of the last stages, and as a result the total quantity of water required for either the once-through or the brine recirculation system is about the same.

This system offers the advantage that deaeration can be accomplished before heating, thus reducing the corrosive action of the sea water. Also, in operating at higher temperatures when feed treatment is required, the recirculation system requires less feed treatment than the once-through system. The cost of feed treatment is an important element in the total cost of water.

By considering these three fundamental systems, it was possible to design a single unit for Mandalay capable of being operated in accordance with any of these three systems.

With a production capacity of up to 150,000 gpd, it was integrated with an existing steam power plant, without major alterations to the primary plant equipment. For requirements much beyond 2½ million gpd,

5. solar distillation, using sloping glass or plastic plates covering a long narrow black surfaced basin containing sea water, the plates transmitting solar energy which is absorbed in the basin, vaporizing the salt water which condenses on the transparent cover and surfaces.

Significance to Power Industry

What is the significance of salt water conversion to the power industry? G. E. Sonderman, partner in the New York consulting engineer firm of Singmaster & Breyer, puts it very well in a recent ASME paper:

As construction costs increase, and as available water supplies become more remote, the cost of natural water supplies increases. The costs of sea water conversion, on the other hand, are being greatly reduced by rapidly improving technology.

To date the only large commercial conversion plants are based upon distillation. The economy of production therefore depends upon, first, low-cost energy, and second, low capital charges.

If free energy were available, distilled water could be produced for costs approaching the 40 cents per 1000-gal target set by the Office of Saline Water.

Such free energy can be approached by using the waste heat from diesel engines or gas-turbine exhausts as the low-level heat source in salt water distillation.

In the steam power industry there is a major potential source of energy now being wasted. That is the heat content of steam going to condensers. By using a sea

5 SALT WATER CONVERSION DEMONSTRATION PLANTS by the U. S. OFFICE OF SALINE WATER Dept of the Interior

1 Long-tube vertical multiple effect distillation, sea water: 1 million-gpd capacity, at Freeport, Texas.
Construction: $1,246,250, Chicago Bridge & Iron Co.
Architect-engineer: W. L. Badger Associates

2 Electrodialysis process, brackish water: 250,000-gpd capacity, at Webster, S.D.
Construction: $482,200, Asahi-Austin.
Architect-engineer: Bureau of Reclamation, Denver.

3 Multi-stage flash distillation, sea water: 1 million-gpd capacity, at San Diego, Cal.
Architect-engineer: Fluor Corporation, Los Angeles.
Construction: $1,608,000, Westinghouse Corp. (Dept of Water Resources, State of California, will provide up to 50 per cent of the cost of construction.)

4 Forced-circulation vapor-compression process, brackish water: 250,000–1,000,000-gpd capacity, at Roswell, N.M.
Architect-engineer: Catalytic Construction Co.
Budget estimate: $1,900,000.

5 Freezing process, sea water: 150,000–350,000-gpd capacity, at Wrightsville Beach, N.C.
Budget estimate: $1,600,000.

however, the power plant would require integration with the distilling plant in the initial design phases.

Reporting on a year's operating experience at Mandalay, R. E. Whistler, mechanical engineer for the utility, now estimates on the basis of the U.S. Office of Saline Water procedure that a plant following the design of the Mandalay experimental plant and of a 10,000,000-gpd capacity would produce water for a total cost of less than $1 per 1000 gallons.

Actual cost data for the 100,000-gpd demonstration plant have been maintained. Whistler estimates that total cost for operating the experimental plant is $1.92 per 1000 gallons as shown by the following cost analysis.

Method of operation—Once-through, 195 F with chemical feed treatment	
Output, gpd	114,000
Annual operating hours	8,332
Output, annual, gal	39,577,000
	Cost $ per 1000 gal
1. Operating labor	.081
2. Power	.100
3. Steam	
High Pressure	.062
Low Pressure	.296
4. Chemicals	.053
5. Miscellaneous supplies	.006
6. Maintenance	.202
7. Total operating cost	.80
8. Fixed charges*	1.12
9. Total cost	1.92

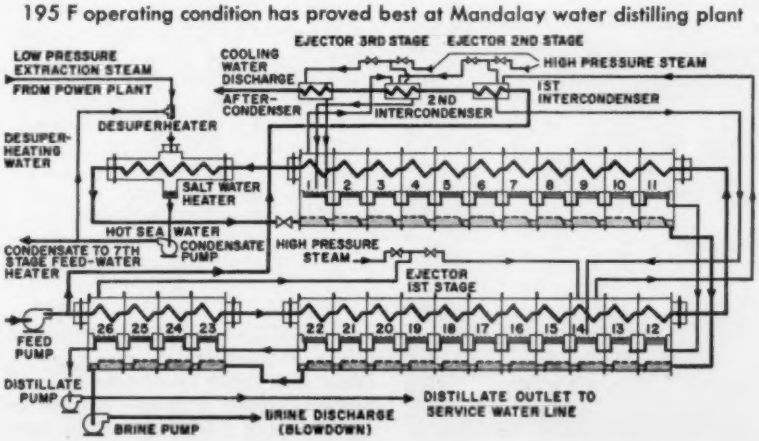
* Figures at 15.75% of capital cost

It should be noted the operating costs for this plant are higher than for a commercial plant due to the experimental work that is being done, requiring more operating labor and electric power and supply. Also, the fixed charges are higher due to the special experimental features.

Whistler's conclusion is that as a result of experimental work to date, satisfactory operation of the sea water distillation pilot plant has been achieved. At 195 F, using the once-through method of operation, chemical feed treatment has been effective in reducing scale formation. At 175 F, operation is essentially scale-free. The higher thermal performance obtained with higher operating temperatures makes the 195 F operating condition more favorable.

Chemical feed treatment has not effectively reduced tube fouling when using the recirculation method of operation due, it is believed, to foreign material present in the sea water feed supply at Mandalay.

195 F operating condition has proved best at Mandalay water distilling plant



water conversion plant as the "condensers" for a high-pressure steam power plant cycle, some rather startling economies result. True, to be useful for water distillation, the steam cannot be as fully expanded as in condensing power-plant practice. But, if the steam were exhausted at 5 psig, it could distill a lot of sea water.

What, then, is the value of such 5-psi steam? One approach is to charge the steam at the residual value only; that is, the loss to the power plant by not having the last of this steam expansion transformed into electricity. In these days of supercritical pressures for modern steam power stations, and with the advantages of reheats and regenerative cycles, the amount of electricity generated by the last expansion into the condenser is a small part — less than 20 per cent — of the total. Therefore, one might fairly set the value of steam so diverted to a sea water conversion plant at only 20 per cent of its initial cost. This surely provides a low-cost energy source for distillation.

THESE PLANTS ARE PRODUCING STEAM AND FRESH WATER

1 2 3

Several utilities have examined this situation. Preliminary calculations indicate that by combining a distillation plant with a modern power station, water from the sea would cost less than 60 cents per 1000 gallons.

This is by no means incentive enough for the power industry to get into the business of salt water conversion in most regions, including the United States. However, there are numerous arid countries, and some places in this country where, for greater over-all economies, engineers could well examine the marriage of water and electrical production in salt water conversion plants.

A specific example is Key West. Its potable water comes by pipeline from wells which tap an ample underground supply on the mainland of Florida, 129 miles away. The existing pipeline cannot supply the increased demands along the Florida Keys, and so it effectively circumscribes their economic development. A second pipeline could be built. It would be costly and it would be vulnerable to destruction at the many exposed bridges from key to key. A salt water conversion plant seems a natural solution for Key West. Since the city has its own municipal steam power pant, the principles of combining water and electrical production could readily be applied.

The significant change in the picture today is the greatly reduced capital cost of distillation equipment. For large plants producing at least 1,000,000 gal per day of fresh water, distillation equipment can be purchased

③ ARUBA—$1.75 COULD BE $1.60/1000 GALLONS AT FULL LOAD

COMPLETED IN MID-1959, the new $11,000,000 fresh water plant for the semi-arid island of Aruba in the Dutch West Indies, off Venezuela, was designed by the New York engineering firm of Singmaster & Breyer. Since Aruba needed not only a new fresh water plant but also more electric power, the installation incorporates a power plant of 15,000-kw installed capacity. The power plant exhausts its steam to the 2,700,000-gpd water-distilling plant. By applying the profit from the sale of electric power to the cost of water, Aruba is making fresh water from sea water at $1.75 per 1000 gal. For 100 per cent load, reports director of waterworks S. J. Faber, this figure could be reduced to about $1.60 per 1000 gal.

The Aruba plant uses the submerged-tube multiple effect distillation process, in evaporators made by G. & J. Weir of Glasgow, Scotland.

Figs. 1 and 2. Close-up and aerial view of the evaporators at Aruba plant. Power plant which furnishes energy for distilling process is seen lower left in Fig. 2. Arm of Caribbean sea at right

By using a series of six effects, one pound of steam can produce 4.88 pounds of fresh water. In this case, this number of effects gave the optimum yield for the capital investment.

For flexibility, the Aruba plant has five independent sets or lines of sextuple-effect evaporators. Each line has a capacity of 540,000 U.S. gallons per day of fresh water.

Source of energy for both the fresh water and the electricity made at Aruba is heavy residual fuel from the local Lago refinery. The oil is burned in two Babcock & Wilcox 200,000 lb/hr boilers (one a standby) which operate at 875 psig and 820 F. Make-up is distilled water from the evaporators; there are two 500-hp boiler feed pumps.

Steam from the boilers enters two turbine generators, each rated 7500 kw at 0.75 power factor. They exhaust against a back pressure of 20 psig. The turbine exhaust, which is fed to the evaporators, varies with electrical demand, and so any steam supply deficiency is made up by reducing and desuperheating the high pressure steam. Additional turbines can be added in the future and fed

MANUFACTURERS OF DESALTING EQUIPMENT

Badger Mfg Co.
Cambridge, Mass.

Cleaver-Brooks Special Products, Inc.
Waukesha, Wisconsin

Davis Engineering
Div of American Metal Products Co.
520-T Main Ave.
Wallington, N.J.

Fairbanks Whitney Corp.
745 Fifth Ave., N.Y. 22, N.Y.

G. & J. Weir, Ltd.
In the U.S.—Weir Chicago Bridge,
50 Broad Street, N.Y. 4, N.Y.

General Electric Co.
Schenectady 5, N.Y.

Griscom-Russell Co.
Massillon, Ohio

Ionics, Inc.
152 Sixth St.
Cambridge 42, Mass.

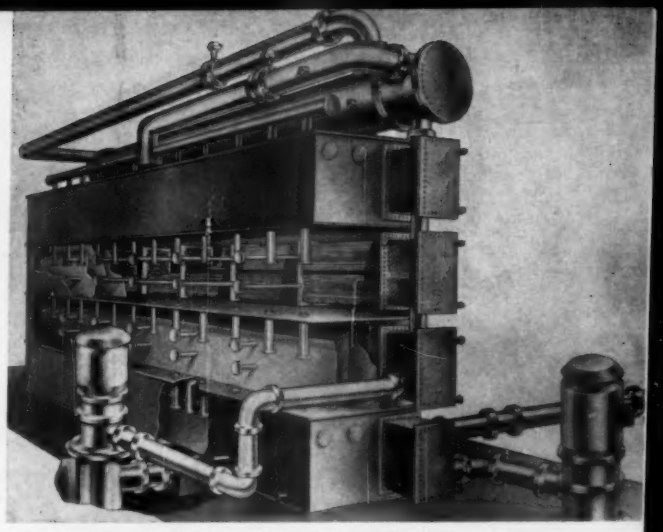
Lummus Co.
385 Madison Ave.
New York, N. Y.

Maxim Silencer Co.
Div of Emhart Mfg Co.
85 Homestead Ave.
Hartford 1, Conn.

Mechanical Equipment Co.
861 Carondelet Cor. St. Joseph Sts.
New Orleans 12, La.

Richardsons Westgarth & Co., Ltd.
58 Victoria St.
London, S.W. 1
England

Westinghouse Electric Corp.
Pittsburgh 30, Penna.



This flash evaporator by Westinghouse for sea water conversion plant in Kuwait is one of four, will make 630,000 gpd

for about one half of what it cost in 1955. An easy figure to remember is $1 per daily gal of capacity. Even this figure is being substantially underbid by a number of manufacturers both here and abroad.

Sonderman concludes: The number of sea water conversion plants around the world is certain to increase in coming years. Unless there is a sudden breakthrough by a process still in the laboratory stage, it appears safe to predict that these new plants will be of the distillation type, and that some will combine conversion with electric generation to bring fresh water from the sea to arid lands at lower costs than hitherto thought possible. THE END

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from the second boiler if local electrical demand warrants.

The two features of this power plant that are different from the usual 900-psi plant are:

1. The absence of condensers on the turbines. This permits a smaller, simpler, and cheaper turbine room.
2. The need for an extensive installation of pressure-reducing and desuperheating systems.

Key to the high plant efficiency is the Scalemaster, a special process which prevents salts in the concentrated brine from depositing on equipment surfaces. Supplied by Weir, its proved performance is based on a ferric chloride treatment of the sea water which keeps dissolved calcium and magnesium salts in solution.

The Caribbean Sea, with a salt content of 35,000 ppm and a temperature of 85 F, is the source of water. Sea water enters a concrete intake chamber at the water's edge several hundred feet from the plant. Here it is chlorinated to kill barnacles and algae which would otherwise clog pumps and piping. Vertical pumps in the chamber force the water through aboveground piping to the distillation plant.

At the plant, the sea water is first used as a coolant in the distillate condenser. Next it flows through two preheaters and into the 5th effect where it receives the Scalemaster treatment and is partially evaporated. It then passes through a series of four preheaters associated with the evaporators, through the 1st, 2nd, 3rd, 4th, and 6th effects in order, and then through the final condenser. Vapor pressures vary from about 4.30 psig in the 1st effect to 26½-in. Hg vacuum in the 6th effect.

Two water streams leave the distillation section of the plant: the waste brine at 130 F and about 75,000 ppm salinity which is pumped back to the sea; and the distillate. The latter contains less than 5 ppm of solids, has a temperature of 103 F, a pH of 5.5, and like all distilled waters, a bland and rather unpleasing taste.

This distillate is split into two streams, one for Aruba and one for the Lago refinery. That for Aruba has its low pH corrected to 7.2 and its taste improved by passage over coral limestone and by aeration. It is then chemically treated to raise its pH to 8.3, filtered, and stored in four 3,300,000-gal aboveground steel tanks, ready for distribution to Aruban consumers. The water for Lago has its pH adjusted by chemical treatment. THE END

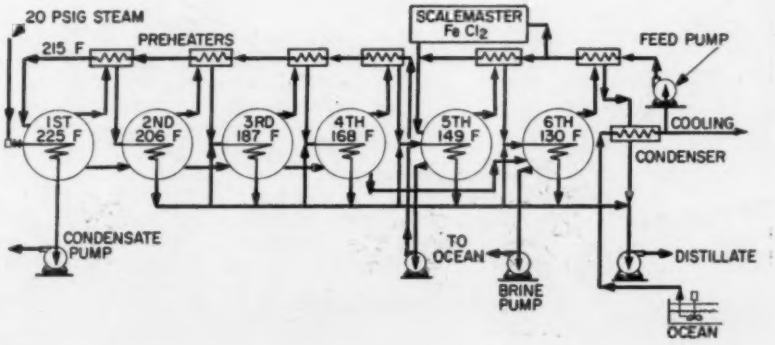
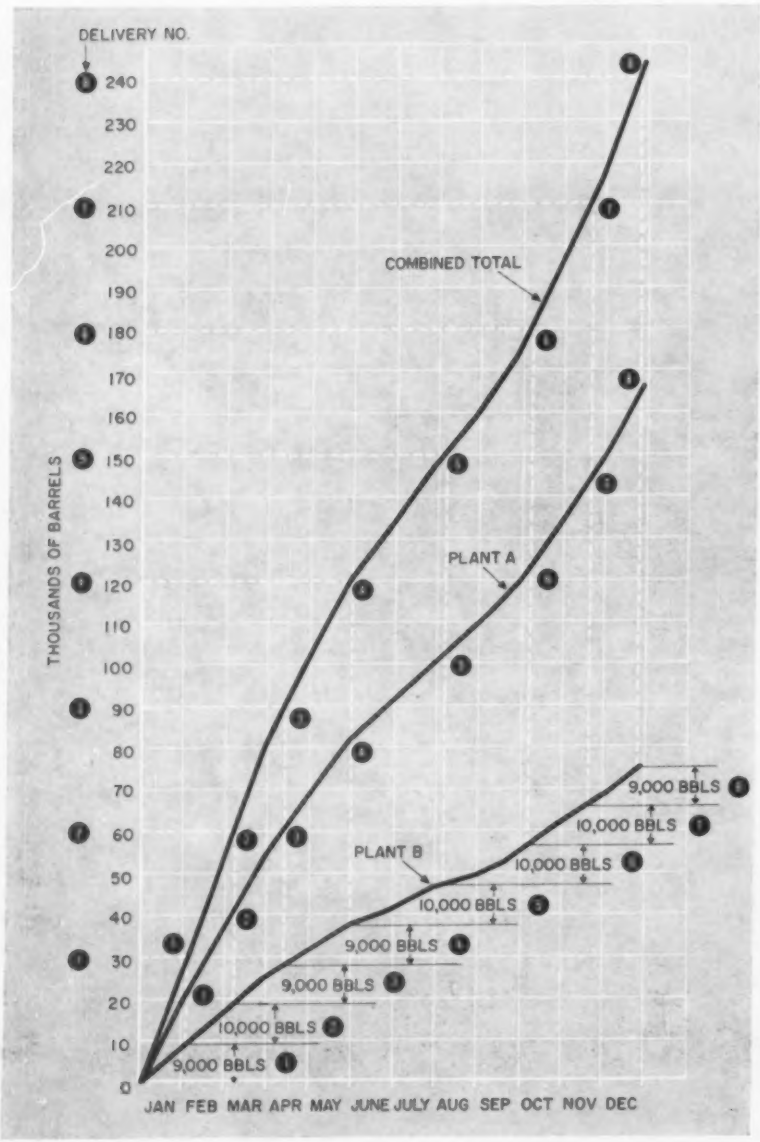


Fig. 3. Aruba plant uses the submerged tube multiple effect distillation process

HOW POWER PLANTS SAVE MONEY FROM PROPER SIZE FUEL OIL TANKS

PROJECT ENGINEER SHELTON EHRLICH EXPLAINS METHOD USED TO RECEIVE LARGER BARGE SHIPMENTS OF OIL



ONE OF OUR multi-plant clients wanted to decrease his fuel oil costs. After a complete study, the answer was to increase storage (and take larger deliveries), thereby reducing barge rates. Sound simple? Not really, because of a rather special situation.

This client had two plants: Plant "A" — located on the south bank of a river, and Plant "B" — located on the north side — shared delivery of fuel oil by barge. Plant A could store 32,000 barrels, and could not let its supply drop to less than 10,000 bbl. Plant B could store only 5000 bbl, and could not let its inventory drop below 2000 bbl. Due to its small storage capacity, Plant B needed deliveries often. Therefore, a 10,000-bbl barge was used to service the two plants, at a delivery charge of 15 cents per bbl.

Investigation showed that a considerable saving could be effected if fuel oil could be purchased in 30,000-bbl barge shipments. So the problem was to determine tank sizes at the two plants, to best store the added quantity of fuel oil. The delivery charge would be only 8 cents per barrel, and the saving would total $17,000 per year.

Since the plant used oil at different rates, and there were seasonal variations, there seemed to be no mathematical solution. Guesswork would not do, since capital costs had to be kept to a minimum. We devised a graphical solution, the construction of which is illustrated in the accompanying table.

This table is simply a tabulation of monthly oil consumption at each plant, totals for both plants, and cumulative totals for the three factors.

Then, from the data compiled, a set of graphs was made. Starting from an arbitrary zero, we plotted the *Total-to-date* column for the typical year, and connected the points with straight lines. (See illustration.) And here's how the system operates:

(1) Find the point on the *Total* curve which corresponds to delivery of 30,000 barrels (horizontal dotted lines). Drop vertical lines to intersect individual plant curves. Due to the construction of the curve, the vertical distance between successive intersections is the amount of oil which must be taken by each plant.

(2) From the graph it can be seen that deliveries in March, August, October and November would require 10,000 barrels to be taken by Plant B. Since they have 5000 bbl capacity *now*, and 2000 must be kept in storage, the new tank should be 10,000 + 2000 − 5000 = 7000 bbl.

(3) At Plant A, where 10,000 barrels had to be kept in storage, the graph shows that the plant was required to accept no more than 21,000 bbl, which left a minimum of 11,000 bbl in storage.

As a result of this analysis, a 7000-bbl tank was installed. The investment in additional tank capacity was amortized in a period of less than two years. THE END

	PLANT A		PLANT B		TOTAL BOTH PLANTS	
	Fuel Oil Bbl	Total to Date	Fuel Oil Bbl	Total to Date	Fuel Oil Bbl	Total to Date
January	20,000	20,000	9,000	9,000	29,000	29,000
February	17,000	37,000	8,000	17,000	25,000	54,000
March	18,000	55,000	9,000	26,000	27,000	81,000
April	14,000	69,000	6,000	32,000	20,000	101,000
May	13,000	82,000	6,000	38,000	19,000	120,000
June	9,000	91,000	4,000	42,000	13,000	133,000
July	9,000	100,000	5,000	47,000	14,000	147,000
August	9,000	109,000	3,000	50,000	12,000	159,000
September	10,000	119,000	5,000	55,000	15,000	174,000
October	14,000	133,000	7,000	62,000	21,000	195,000
November	15,000	148,000	6,000	68,000	21,000	216,000
December	19,000	167,000	8,000	76,000	27,000	243,000

E.E.I. COMMITTEE MEETS IN ST. LOUIS

ONE OF THE Edison Electric Institute's most active committees met in St. Louis recently. The Electrical System and Equipment group — under the capable chairmanship of R. G. Meyerand of Union Electric Co — held a most interesting meeting, attended by a large number of members and guests.

Sessions were devoted to regular Committee business, status reports of sub-committees, and a special program relating to the development of the Taum Sauk pumped-storage hydro project.

A feature story on Taum Sauk appeared in the November and December issues of POWER ENGINEERING, authored by George P. Gamble, executive vice-president of Union Electric. Also, Mr. Gamble delivered the opening talk to this EEI Committee meeting and discussed the philosophy and development of the project.

He was followed by Barrett M. Carothers, who talked on the history and economics of the project. His discussion was most enlightening and proved the economic wisdom in constructing this project.

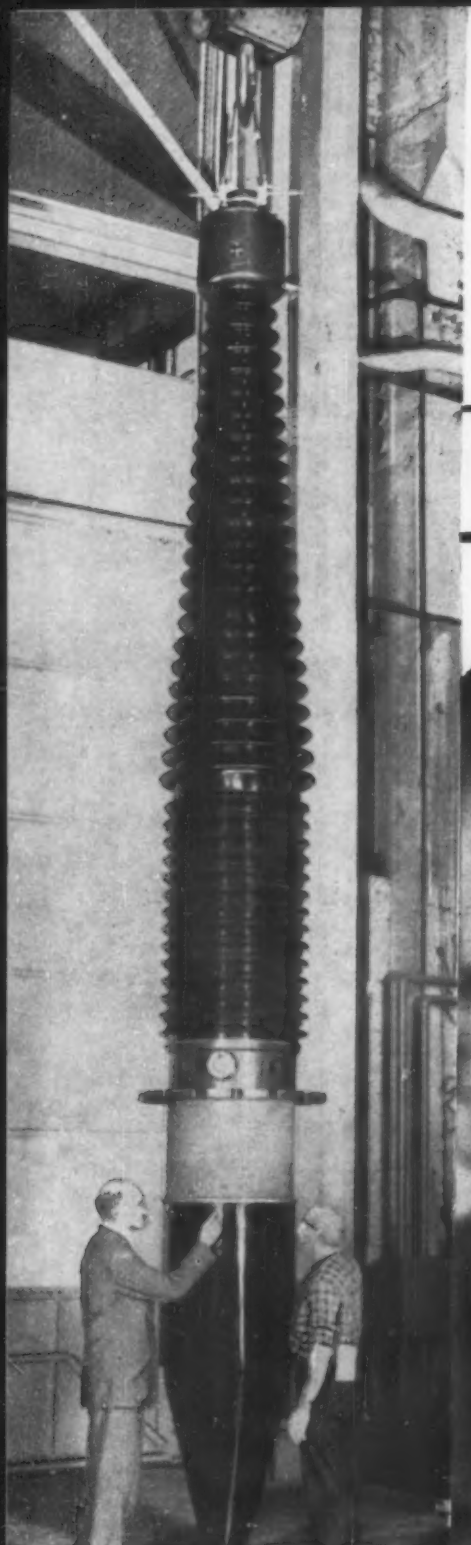
After Mr. Carother's talk, E. A. Rudulph gave an excellent discussion of the design features of the plant. On the subject of electrical generation and transmission features of the project, R. W. Gaskins gave a thorough analysis of the details, both in the plant and on the transmission lines.

After the talks by Messrs. Gamble, Carothers, Rudulph and Gaskins, interesting discussions were given by pre-selected power engineers. These discussions were presented by Bob Peetfield, Stone & Webster; John Kinghorn, American Electric Power; John Warts, G. P. U. Co; K. M. Smith, Commonwealth Edison Co; Walter Simmer, Ebasco; and Harris Barber, Consumers Power Co.

Most of these discussions raised questions which required answers from the speakers. This was accomplished in excellent fashion, and all questions were answered most satisfactorily. This session proved most conclusively that the engineers of Union Electric, together with their designers and consultants, have done a magnificent job of engineering this famous project.

From the interest shown at this meeting, it is quite evident that nearly all utility companies have more than a passing interest in pumped storage for peaking use. Although Europe has many years of experience in this type of hydro power, the American plants are few in number. Until recently, there was not much interest in pumped storage here; however, the pace has accelerated rapidly in the last year or two.

After the discussions of the Taum Sauk project, balance of the meeting was devoted to progress reports of sub-committees, and regular Committee business. THE END

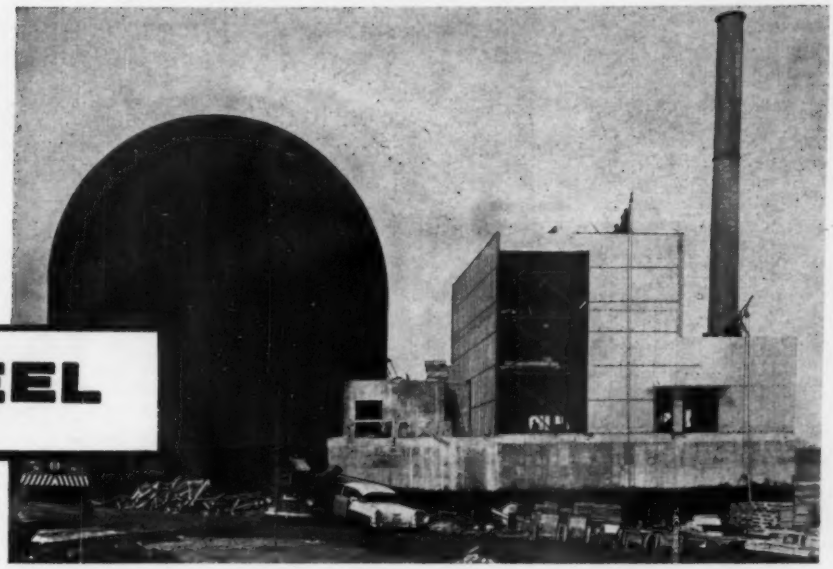


This 1800-kv BIL condenser bushing weighs 6850 lb and is 23½ ft high. It was designed and built by Westinghouse for use on transformers with a high-voltage rating up to 750,000 v. The design includes provisions to assure low temperatures in the bushing conductor and insulation structure. The bushing will be used in developmental work on ultrahigh voltage transmission systems

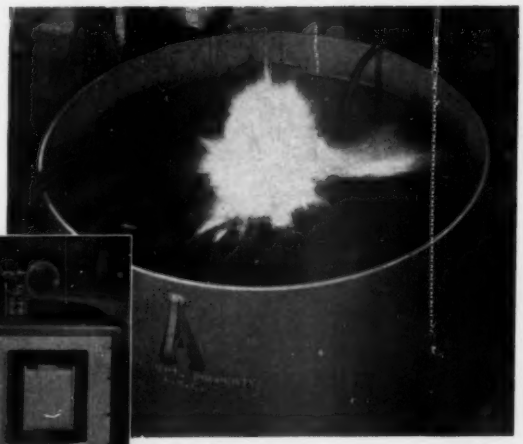
Power Engineering's

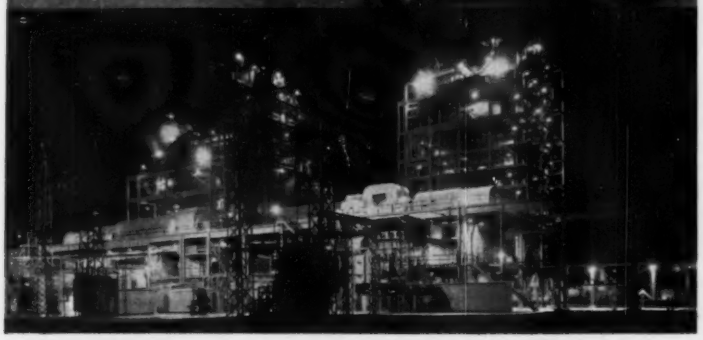
Boeing fir-tree turbine wheel for the company's T50 gas turbine engine has mechanically attached buckets, each being held in place by a metal key. Fir-tree assembly allows replacement of damaged blades. These wheels turn up to 38,000 rpm. Hub shown is broached from a high-temperature high-strength Inconel X forging

NEWS REEL



First atomic power plant to be operated by a municipal utility is this 11,400-kw station being built at Piqua, Ohio, by Atomics International. It is part of AEC's power demonstration program. An organic moderated and cooled reactor goes in dome-shaped housing. Other building contains process equipment





Controlled electrical explosions are being used by GE as a low-cost way to shape hard-to-form metals. Explosions induced through a build-up of electrical energy available at about 35,000 v create shock waves which blow intricate contours into metals in millionths of sec

Battery of radiation monitors built by Victoreen Instrument Co will sample air particles at AEC's nuclear power plant at Hallam, Nebr. Particles drawn through units lodge on filter paper and are subjected to extremely sensitive measuring

T. H. Wharton Station of Houston Lighting & Power Co. Unit at left is an Allis-Chalmers 220-Mw tandem trip e-flow turbine which incorporates new features to minimize distortion and control thermal expansion. From its start June 1, 1960, it has had very high availability factor

FEEDBACK

IN FEBRUARY, WE PUBLISHED AN ARTICLE ENTITLED "NEEDED—A REAL POWER CONFERENCE AND SHOW." ALTHOUGH WE HAD OUR OWN IDEAS ON THE SUBJECT, THE ARTICLE WAS A TRIAL BALLOON—SIMPLY TO POLL THE POWER INDUSTRY, TO SEE IF WE'RE RIGHT OR WRONG IN OUR DIAGNOSIS

IT SHOULD BE REITERATED that *we* have absolutely no intention of trying to organize any type of new movement. We have our hands full, just publishing a good power magazine, without trying to organize some new "movement." We do feel, however, that the best existing Conference should absorb some of the lesser ones.

Regardless of anything else, the reaction to our editorial has been most gratifying! And, we might add, quite explosive. Letters have been pouring in to comment on the article — both pro and con. Some readers have given high praise to our proposal; others say the idea is fine but impractical; and, not just a few have literally "torn us limb from limb."

This type of reader reaction is exactly what we'd hoped for. If we had received only a few responses — or if the readers' letters were all laudatory — we would know that our proposal had met with complete failure.

We've already proved one point: we aren't alone in our feeling that "something should be done." Even those who stoutly defend the present status of conferences admit that there are too many of them.

Some readers have asked, "What's wrong with such-and-such a Conference?" or "What do you have against this Society, or that Society?" Truly, we are not *against* any existing system; we simply believe there must be a *better* one.

In our February article, we did not make specific recommendations as to a *modus operandi;* it isn't our prerogative to do so. Now, however, we *can* express our opinions more definitely because we've been heartily challenged by some of our readers.

First — and as several readers asked: What's wrong with the American Power Conference? We say: Absolutely nothing is wrong with it; in fact, we feel it's the logical Conference to preserve — and expand. The APC has an enviable history of development and commands the respect — and highest regard — of the entire power industry.

Next, we found that a few readers thought we were suggesting an *additional* power conference. Guess we didn't make ourselves quite clear, because our primary objective was to suggest *fewer* conferences.

As to *frequency* of this proposed Conference and Show, it is our feeling that such an event should be held not oftener than every two years, and possibly it would be most successful if held every three years.

Just to prove that we "hit pay dirt" in our proposal, we'd like to quote a few excerpts from some of the letters we've been receiving. And, most of these letters are from highly respected power engineers, whose opinions we value highly.

HERE ARE SOME REMARKS, PICKED AT RANDOM, FROM READERS' LETTERS:

I wholeheartedly agree there is a definite need to re-shuffle the organizations, so as to better group the people interested in a common subject. Your approach to this problem in the field of power seems to be a very logical one; however, I feel it would be a very difficult task to accomplish. Since you have asked for comments relative to the principle, not the method of effecting it, I can only comment that I feel it is very worth while.

I do think it should be recognized that before the various manufacturers, such as ourselves, could wholeheartedly support such a conference, it would be necessary to be assured, in one way or another, that the organization would have the wholehearted support of the various purchasers and societies, and not that it would just mean an additional conference which we would have to cover in a year's time.

Your suggestion would undoubtedly result in a huge gathering, from a physical standpoint. It would have to be severely regimented in order to function. This to my mind would materially reduce the effectiveness of it — for the individual. I feel that most of the founder society meetings today, as well as many others of a national character, are much too large to be of particular benefit to the individual. I prefer the smaller, more intimate type of gathering.

I believe your proposal could do much to integrate the various interests in the power field on a sensible basis. At any rate, I agree with your comments that the present situation leaves much to be desired. Admittedly, this is a difficult subject, and a difficult market, to serve in all its various aspects and interests; but, just because the power field is so broad, and shows promise of broadening even further in both product and application, we need the fresh look which your proposal seems to offer.

Judging from our visit to the last Power Show here in New York, something is very definitely amiss. There were so few exhibitors, that only two floors were used — partially. Where once "making the grand tour" meant sorely aching legs the next day, this year it was a breeze. Of course, this is strictly one man's opinion, yet it seemed to us that even the salesmen manning the booths were more listless than they usually are.

We certainly feel that the suggestion included in the article in the February issue of POWER ENGINEERING is most timely and desirable. It would seem that a single really great conference, combining the desirable features of the ASME-AIEE power conference, the American Power Conference, and the National Power Show, would be highly desirable.

The great difficulty, of course, is for the various societies and conferences to agree to pool their resources and to work together. Each seems to feel that they may lose some prestige in not being the "top dog" in the conference. Perhaps if there is enough pressure, some of these petty jealousies can be buried, and we may have a true coöperative engineering profession in the power field.

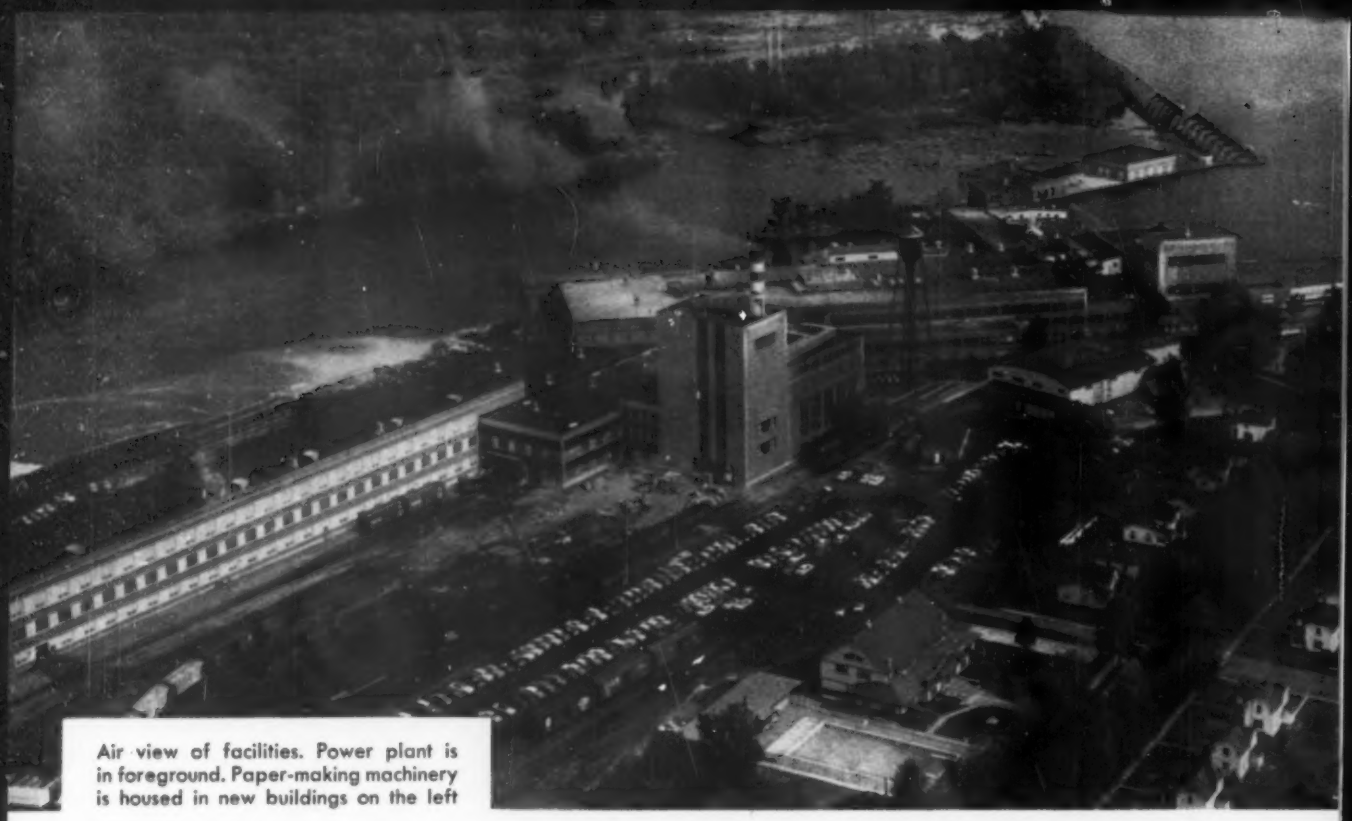
Let me say at the outset that my mind is open — I am willing to be convinced, but frankly I am skeptical. We already have far too many conferences and meetings on a national scale. If a number of the existing ones could be eliminated by your suggestion, I would be inclined to favor it. I am doubtful, however, that any of the existing societies and associations would be willing to eliminate, or substantially reduce, their activities in favor of a single power conference and show.

I am employed as a power plant design engineer by a large chemical company, and as such am vitally interested in the power field. I, too, have noted that truly power subjects have been spread fairly thin in most of the national society meetings. I have felt that the American Power Conference has most nearly met my ideas of an excellent meeting devoted to my interests. The competition of the National Power Conference (ASME) would seem to drain away some of the appropriate papers and personnel from the Chicago meeting. I am limited, as are many other men in my field, in the number of these conferences I can, and want to, attend. All ten of your suggestions are noteworthy — including the show, if it can be made to truly cover the subject. Confining the conference to power engineering and omitting the awards, frills, and research topics would appeal to most of us.

Power, despite all the hue and cry about outer space, is still a very basic, and tremendously important, field. If all those who are vitally concerned with it will band together, as you have suggested, no doubt some of its former glory can be recaptured. It will take hard work, but with the support of all the top men in the field, it can be done.

I feel you have done a disservice to the American Power Conference. The editorial fails to acknowledge the excellent work done by the group which has for several years been filling the gap you point out. I have attended most of the conferences since its inception as the Mid-West Power Conference. Instead of starting a new conference, it would appear to me that much more could be accomplished if your efforts could be directed toward aiding this group. The American Power Conference at Chicago has more and more become International in attendance.

The basic reaction I have to the proposal set forth in the article is that we don't need still another group, or show, to compete with the ones we already have. I believe that we already have, right here in the Midwest, a good power conference in the American Power Conference, which is truly devoted to power in all its aspects. I think that the Conference meets all the requirements set forth in your article, with the one exception that a show is not part of the arrangement. Personally, I have never felt that a show was a necessary, or even desirable, adjunct of a conference. I would agree that the ASME annual meeting does not meet your requirements of a power conference as well, but of course the scope of the society's interests cannot permit this "exclusive" power approach. Again, what's the matter with the American Power Conference?



Air view of facilities. Power plant is in foreground. Paper-making machinery is housed in new buildings on the left

PROCESS INSTRUMENTS AVERT PRESSURIZED FURNACE BACKFIRE

LEVEL DETECTING DEVICE MONITORS FLOW OF COAL TO FURNACE

MODERN high-efficiency, pressure-fired furnaces, such as Babcock & Wilcox "Cyclone-fired" furnaces, require a constant flow of crushed coal under pressure. Accidentally interrupt this flow of coal, and expensive troubles may result. When a "flame-out" occurs, downtime, costly repairs, and possible injury to personnel are possible.

Blame the problem on clogging that can result when a powder-like material flows from a hopper through a pipe. Gaps or bridges often occur just from the normal settling and compacting of the material through the action of gravity. Normal plant technique calls for either a strong man with a sledge hammer or the activation of an electrical vibrator. But when manual observation is either out of the question or far too expensive, man's ingenuity is called upon to come up with a new solution.

This was the situation when a new furnace was contemplated for the Biron facility of Consolidated Water Power & Paper Co. The firm is one of the world's larger specialists in the manufacture of enamel printing papers. It operates a number of paper and power plants in Wisconsin, making use of the company's extensive forest reserves in the U.S. and Canada. The installation is the company's first use of pressurized furnaces.

The Problem

The Biron division manufactures enamel papers utilizing processes pioneered by Consolidated — enormous paper machines up to 420 feet long, traveling at speeds as high as 1800 feet per minute. This is in addition to raw pulp processing. In an operation of this size, considerable amounts of steam are required, both for in-plant power and for operation of the five paper machines. Additional steam is also needed for the pulp operations. To provide the large amounts of steam needed, high-efficiency units, utilizing a pressurized furnace, were selected.

Use of this equipment created several engineering problems relating to fully automatic operation of the coal feeders supplying the crushed coal to the boilers. Because the furnace operates under pressure, with this same pressure imposed upon the discharge point of the coal feeder where it enters the firing chamber, it became imperative that a uniform height of coal be maintained above the discharge point to provide an adequate seal. The height of the coal column had to be great enough to prevent "back-up" of the injection pressures and to prevent "back-fire" of the hot gases into the coal-feeding apparatus.

After considerable study and evaluation of currently available continuous monitoring systems applicable for the detection of voids in the coal column, caused by clogging of the coal either in the column or in the hopper, a capacitance-actuated ma-

terials presence detector was selected. The detector, Robertshaw's Level-Tek, is utilized for the detection of voids by insertion of a probe into the side of the coal feeder with the end of the probe in the coal column.

Two units are used for each coal feeder, one in the upper portion of the coal feed pipe, just below the coal bunker. At this point the device is able to detect voids formed in the bunker or at the very top of the coal column. Should it detect a void, it automatically, without supervision, starts a bunker vibrator located on the side of the coal bunker. This vibration breaks the coal clog and restores normal coal flow.

Detection device chosen has many industrial applications, most frequently in "go, no-go" materials level detection. It consists essentially of an electronic circuit which is designed to oscillate when the probe is not in contact with material. The circuit, a Hartley oscillator, is extremely sensitive to changes in capacitance at the probe. When the capacitance of the probe increases (as material around the probe decreases) the circuit begins to oscillate, causing a decrease in plate current and permitting a relay in the plate circuit to operate. The contacts of the relay can be connected to any type of external equipment — in this case, the bunker vibrator.

As long as there is no coal contacting the probe, the circuit oscillates and the relay contacts remain activated. Once the vibrator breaks the clog and coal resumes its flow, the coal around the probe decreases the capacitance of the probe and stops the oscillation. This action reverses the relay, opens the contacts, and stops the vibrator.

Operating Principle

Probe is Teflon covered and cannot become coated with coal dust to give false indications, as coal does not cling to this material. The rugged probes are further protected by a shield in the direction of the coal feed pipe entry. An air-tight sealing gland is used to mount the probe through the feed pipe to prevent the escape of coal dust. The gland also provides the needed insulation between the probe electrode and the wall of the feed pipe.

Actually, the probe acts as one electrode of a capacitor, while the wall of the coal feed pipe itself becomes the other electrode. Thus, the air capacitor formed by the probe and the wall of the tube becomes a coal-dielectric capacitor when coal flows through the tube. Since air has a dielectric constant of *one*, and materials have dielectric constants other than that, the device simply detects the capacitance difference of air between the probe and the pipe wall, and coal between the probe and the pipe wall.

No Overseeing

A second monitoring system is located at a low point in the coal feed pipe, 4 ft 9 in. above the bottom discharge point. This system detects secondary voids formed between the top of the feed pipe and this detection point. Because of the high pressures found here and the proximity of the coal discharge into the furnace, activation of this detector sounds an alarm in the main control center to alert operating personnel. Here the necessary action can be taken to avoid boiler damage caused by voids, free the void, and resume normal feeder action.

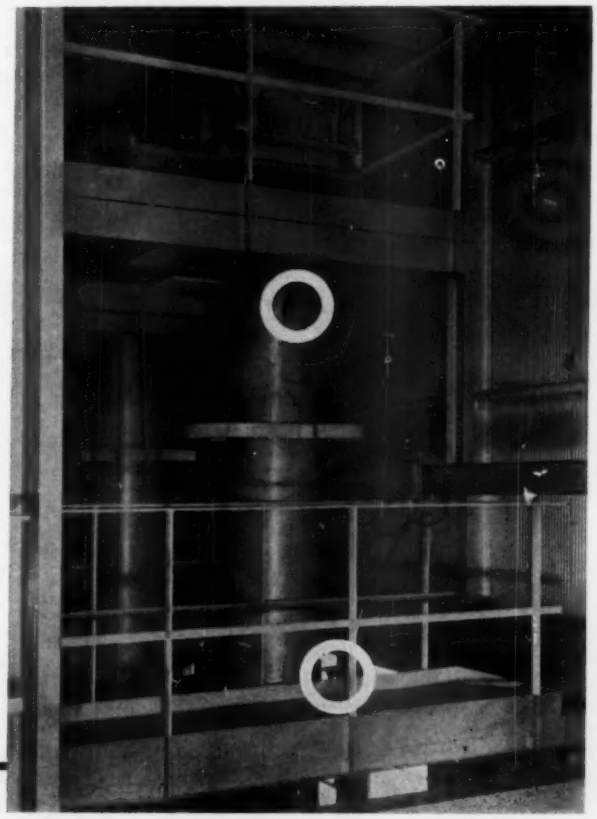
With the exception of operating personnel required to take action in case of a void occurring in proximity to the coal injection point, no overseeing is required to ensure a continuous void-free supply of coal to the burners. In the Biron installation, duplicate feed pipes with a total of four detection units are used.

These systems have provided efficient monitoring of critical areas and have probably saved many maintenance man-hours. The installations have been proved over a period of arduous service, proving an ability to react instantly to operational defects. Fail-safe design of the units provides an additional measure of safety.

Principal reasons for selecting this particular device were the fact that it is fully nonmechanical, thus eliminating any wear problems; that it is fail-safe, thus ensuring that a void would not be passed; and that false readings are eliminated by the Teflon-covered probe. THE END

Editor's note: For more information about "Level-Tek," please write to the Editor, POWER ENGINEERING, 308 E. James St., Barrington, Ill.

In coal feed pipes, normal and safety probes (circled) are shown connected to control units, mounted on framing to right of the feed pipe



USE CANNED MOTOR PUMP FOR CONTROLLED CIRCULATION

G. E. BOLLIBON, OF WESTINGHOUSE ATOMIC EQUIPMENT DEPT,

DESCRIBES CONSTRUCTION AND ADVANTAGES OF THESE PUMPS

OVER 20,000 successful operating hours have been completed by a canned pump in the boiler circulation system of the Possum Point Station of the Virginia Electric Power Company. This prototype, hermetic, gasketed-type canned motor pump has proved to be the answer to a number of vexing boiler water circulation problems.

Pumps of the same design have now been in operation for two years or more at two other power plants with no operating problems. These pumps were inspected after the first year of operation with no apparent wear, and were reassembled for service. These first units were 100 per cent stainless steel pumps similar to the canned motor pump design used in nuclear electric generating stations.

A later design, incorporating the unique features of a removable stator and the use of carbon steels and Type-410 stainless steel, was put into service at the Yorktown Station of the Virginia Electric Power Company and other power plants throughout the country. This design features characteristics that are suited to power applications where maintenance and reliability are the main concern.

During a shutdown at the Virginia Electric Power Company in September, 1959, one of the boiler circulating canned motor pumps located in their Yorktown Power Station No. 2 was removed for inspection. The pump at this station operated for approximately 4000 hours at 7580 gpm, 134 feet head in a 2118 psi, 621 degrees F system. Since put into operation, the pumps were run two weeks on and one week off. A typical performance of this unit is shown in Figure 1.

All rotating parts and bearings were found to be in excellent condition. Both the radial and thrust bearings were in very good condition with no signs of wear. The removable stator cartridge was free and was lifted and rotated easily. The pump was cleaned, reassembled, and reinstalled without repair except for new gaskets and locking devices.

Ensuring Positive Flow

In the design of controlled force circulation boilers, pumps are used to force water through all the steam generating circuits. This insures a positive flow in one direction at all times, regardless of the rate of heat application. Use of a pump makes it possible to use small diameter steam generator tubes which have many inherent advantages in addition to their important role of reducing the amount of water handled by the circulating pumps.

Temperature of the water at the pump is practically equal to saturation temperature at drum pressure if the feedwater is brought up to steam temperature in the drum. The head against which the pump must operate is only that required to supplement or replace natural circulation and to overcome the resistance of the orifices at the entrance to each unit. This amounts to only 40 psi, even when using long generating tubes $1\frac{1}{4}$ inches or less in diameter. Thus, only single-stage impellers are required.

However, the suction and discharge pressure are both a little greater than the boiler operating pressure; so for very-high-pressure boilers, special sealing arrangements are required where the shaft passes through the pump casing. When the pressure difference across the seal is too great for a packing gland, it must be supplemented by a sealing water labyrinth in which the pressure is broken down

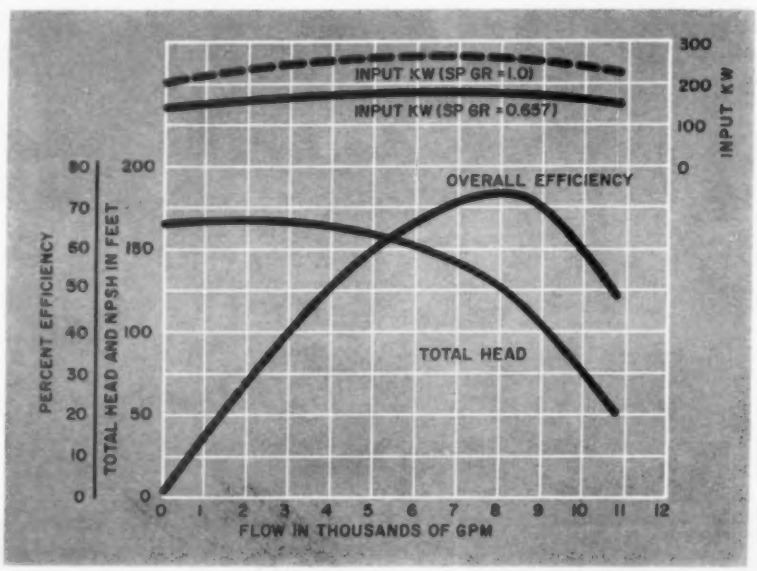


Fig. 1. Typical performance characteristics of controlled circulation pump

to a value for which the packing gland is satisfactory. In accomplishing this result, the water from the pump casing cannot be allowed to flow through the seal because its temperature is too far above the boiling point corresponding to the leak-off pressure.

Therefore, flashing would occur in the seal, resulting in deposited boiler water solids. Also, vibration and ultimate damage to the labyrinth would occur. Many different types of sealing arrangements have been designed and used with some success. However, in addition to a reduction in over-all efficiency, maintenance costs have been high.

Zero Leakage Pump

Zero leakage canned motor pump is a natural for this application. Some advantages of this design are as follows:

1. Eliminates external glands and expensive high-pressure pipe (zero leakage).
2. Eliminates valves and instrumentation to provide injection water for sealing conventional type pumps.
3. Elimination of sealing water improves the over-all station heat rate.
4. Minimum maintenance.
5. Pump can withstand full pressure and temperature at hot standby. It is hot and pressurized at all times.
6. No seal maintenance.
7. No external bearing lubrication (bearings are water lubricated).
8. No adjustments are required when pump is in operation.
9. May be started and stopped at any time at full pressure and temperature.
10. Recovery of heat losses from motor by using coolant from the condensate system.
11. Pump may be started and stopped at any time as long as cooling water is supplied.

As shown in Figure 2, pump is a vertical, single-stage, centrifugal unit and is an integral part of the driving motor. It is supported by the boiler circulating pump piping, to which the pump casing nozzles are welded. No other support is required. Design and arrangements of major components are shown in Figure 2. All parts are precision-fitted, and the complete motor assembly is welded for pressure tightness. Casing is either a double volute, single discharge, or double discharge type. Each provides radial hydraulic balance.

Only connections to the pump are the cooling line connections, electrical connections to the terminal box, and the purge line. The purge line is used only to supply clean water during boiling out and acid cleaning, thus

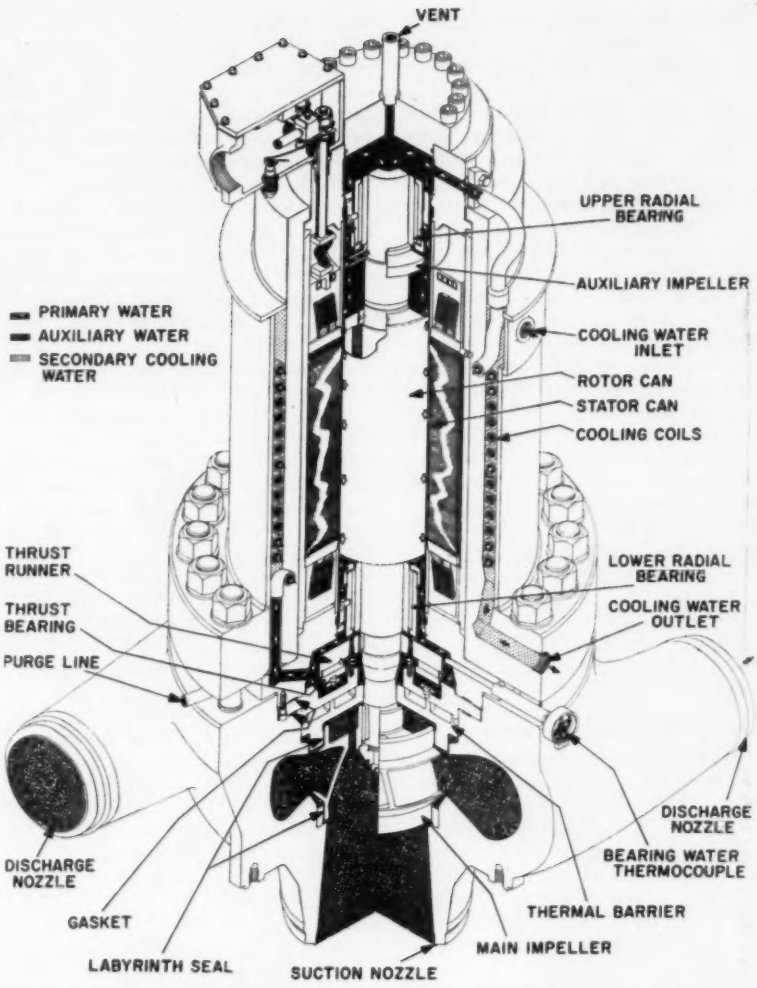


Fig. 2. Cross-section of units showing integral construction of the pump and motor

preventing contamination in the motor cavity with dirty or acid water. Since there is no way of seeing any of the rotating parts of the pumps, a red indicator light in the terminal box indicates when the pump is running.

Electrical connections are polarized for correct rotation. To guard against damage to the pump due to sudden changes in operating conditions, two protective devices are installed: (1) a low-flow alarm on the low-pressure cooling water line; (2) a high-temperature alarm on the motor bearing water-temperature thermometer.

Rotor and stator are both encased in corrosion-resistant cans that are supported to withstand full boiler pressure. This arrangement eliminates the need for a mechanical seal, and the boiler water can enter the motor through the labyrinth in the thermal barrier or thrust bearing support.

Major sources of heat generated in the unit are electrical, hydraulic and friction. The magnitude of these losses makes it impractical to rely on the usual means of heat dissipation, such as external radiation and convection. Therefore, a low-pressure, fresh water heat-exchanger system, a part of which is built integral with the motor, is used to remove excess heat. The two major losses, the stator can loss and the core and water friction loss, are readily transferred to the heat exchanger as a result of the internal water circulating method provided by the auxiliary impeller. This circulating water cools the stator can, rotor, radial and thrust bearings.

Additional energy is added by the thermal and radiation losses at the thermal barrier, plus the heat due to the interchange at the rotating seal. Temperature of the water between the rotor and stator and surrounding the bearings is approximately 150 degrees F and is indicated by the thermometer located in the thrust bearing region.

The pump has three distinct flow

systems, the primary coolant water system, the auxiliary internal water system, and the secondary cooling water system.

When the pump is originally filled and vented prior to starting, clean auxiliary water floods the motor interior. When the primed pump is pressurized and started, the auxiliary water is circulated by the auxiliary impeller at the top of the rotor shaft. From this impeller, water is forced through the gap between the rotor and stator cans and passes through the radial bearings and thrust bearing, back to the coils and heat exchanger. Some water by-passes the gap between the rotor and stator, flowing through and around the radial bearing, and returns to the auxiliary impeller section. No interchange takes place between the primary coolant water in the casing and the auxiliary internal water in the motor section unless a pressure differential exists across the thermal barrier. During normal operation, no measurable quantity of water is interchanged through the labyrinth seals unless the vent valve is open.

Removable Stator

Low-pressure secondary cooling water from an external source is circulated around the cooling coils and between the jacket and stator shell, removing heat from the auxiliary water and stator. This water enters near the top of the motor and leaves in the lower main flange. A flow meter in this low-pressure cooling water supply line provides a means of checking the cooling water flow at all times.

Drive motor is a three-phase, 60-cycle, 440-volt, a-c squirrel cage induction motor with a normal operating speed of 1800 rpm. In the original design, the stator winding is welded inside of the main shell and, in case of stator failure, it would have been necessary to bring the pump back to the manufacturer to remove this assembly. With this newer design the stator cartridge assembly can be removed and replaced at any time in the field. This cartridge assembly consists of a wound stator, stator can, stator backup sleeves, upper stator end ring, and the terminal assembly; and it is designed in such a manner to carry the full system pressure. This assembly fits into the pump casing and lines up the complete unit and also carries the two radial bearing fits. There are no welded connections in this removable cartridge.

Motor is essentially of conventional construction with the following exceptions: (1) the motor winding, which contains no oils or other liquids, is completely closed. Radiation and convection within the chamber provides some cooling, but there is no forced circulation of air; (2) the stator line or can is provided at the bore of the punchings to seal off the fluid from the electrical windings; (3) the motor terminals are brought out through pressure-tight terminal fittings which are designed to withstand full boiler pressure. Though not normally loaded, the terminal arrangement is designed to seal against this pressure in the event of failure of a stator can; (4) the motor has Class "H" insulation and is designed for a maximum hot spot temperature of 180 degrees C.

The stator cartridge assembly consists of silicon steel laminations (punchings) having formed or mush wound coils. The stator is hermetically sealed within a shell and is separated from the system liquid at all times. The slots for the conductors are kept as narrow as possible in order to reduce the stress on the can where it bridges the slots. Beyond the end of the stator punchings, the can is supported by the back-up cylinders. No machining or grinding is done on the can after installation. Extensive leak testing, using mass spectrometer methods, are performed on the can before and after assembly. The complete unit is hydrostatically tested in accordance with boiler code requirements and specifications.

In this design, the pressure is contained and sealed by the main flange studs. Since there are no internal gaskets in this design, the problem of any leakage is eliminated; and, if any of the main gaskets would possibly leak, it would not leak into the motor end but would appear between the main flange and pump casing.

Isolated Rotor

Rotor assembly consists of silicon steel laminations (punchings), end plates, shaft, journal bushings, and auxiliary impeller. The rotor is of the conventional squirrel-cage type, with copper bars driven into the slots surrounding the punchings. The copper bars are induction-brazed to copper connection rings on both ends of the rotor. The rotor punchings are compressed against a shoulder on the shaft, and, while under load, a shrink ring is placed over the shaft against the opposite end of the stack. On cooling, it maintains the stack tightness after the compression load is released. The can encases the rotor and is welded in place, isolating the rotor to prevent corrosion products from entering the system liquid and system liquid from entering the rotor.

There are three bearings in the canned motor pump — upper and lower radial bearings, which are self-aligning, and the thrust bearing. The bearing surfaces are made of Graphitar No. 14, a carbon graphite material in a shell with a spherical seat for self-alignment. The graphitar is in compression in all directions when assembled into the shell. The upper and lower radial bearing assemblies are simply mounted into the stator cartridge by use of snap rings. Complete upper and lower bearing assemblies are identical and interchangeable.

Thrust Bearing Assembly

The thrust bearing is of the pivoted-shoe Kingsbury type; it is made up of metallic segments known as thrust shoes that are assembled by linkage in such a manner that each is self-equalizing and self-aligning. This construction enables the bearing to float on wedge-shaped films of liquid which form between the shoes and thrust runner. The thrust runner assembly is mounted on the shaft at the lower end and runs on the shoe assembly. A Graphitar 14 ring is encased into the runner as the bearing material. In order to conserve space, only a single thrust bearing is used, and the hydraulics are designed such as to give only downthrust throughout the flow range.

Entire pump and motor unit is bolted to a pump casing in a spigot fit. Flexitallic gaskets between the pump casing and pressure housing make the pump leakproof. The main flange, with its studs, secures the unit to the pump casing and withstands the full tension load generated by the system pressure and the thermal load. The main flange and shell are an integral piece which includes an integral heat exchanger.

All pressure parts in this unit are held together by the studs spaced around the casing in the lower flange. With this feature, assembly and disassembly time is reduced since there is no pressure bolting used in the pump. Four bolts are used internally to hold the removable stator cartridge in place, and four bolts are also used to hold the thermal barrier Kingsbury assembly to the stator cartridge until it is lowered into the pump casing. There is no wire or bolt-locking of any type required in this unit. The only internal bolting hardware in this unit are small screws holding the interlocking of the thrust bearing with the locking arrangement. These are secured by means of pant leg washers.

To date, several sizes of units have been developed having capacities ranging from 4000 gpm to 10,000 gpm with heads up to 40 psi. They are capable of operating in pressure systems up to 3000 psi. THE END

HOW WATTMETERS ARE CALIBRATED AND CONNECTED

R. M. ROWELL OF GENERAL ELECTRIC'S INSTRUMENT DEPARTMENT

CLEARS UP SOME WATTMETER MYSTERIES

RECOMMENDED connections for indicating and recording wattmeters on single- and polyphase circuits are normally well understood. Generally, the best practice is to adhere to these standard methods to obtain best possible accuracy. According to Blondel's rule, any polyphase circuit may be metered accurately by N-1 measuring elements where N is the number of wires in the system.

Quite frequently it is impossible to follow this rule without obtaining special instruments at considerable additional cost. Economic considerations may dictate a reduction in the number of expensive high-voltage current and potential transformers with some sacrifice in accuracy; or advantages of more economical or convenient wiring may justify the reduced accuracy.

These considerations suggest that the plant or utility engineer familiarize himself with not only the standard recommended connections, but also many of the "short cuts" and variations possible. The diagrams indicate type of circuit and instrument transformer combinations used, the type of wattmeter required, any necessary special features, and limiting assumptions with sources of error. Lettered arrows on the circuit leads indicate current or potential terminal designations on the wattmeter proper to which connections are made. These markings are symbolic since terminal marking systems are many and varied.

Vector diagrams indicate phase relations at both unity and 0.5 power factor lagging, and may assist in "phasing out" a circuit to check proper connections.

Equations for power indicate how the correct (or approximately correct) measurements of watts are obtained.

As for wattmeter calibration, we have an area in which there seems to be considerable mystery. However, the terms are quite easy to understand and the data straightforward in application and computation.

Calibrating Watts

First, what is this elusive quantity designated as "CALIBRATING WATTS?" To answer this question, it must be understood first that the scale value of a wattmeter may have no direct relation to its current and potential ratings. For example, a single-phase wattmeter rated 5 amperes and 120 volts does not necessarily have a 600-watt scale. It might conceivably have a 1000-watt scale to indicate brief overloads, or, if used on a low power factor circuit, the scale might be as low as 200 watts. Current and potential transformers are installed in generating or industrial plants in accordance with certain standardized values with safety factors and growth allowances; so their ratings may exceed the maximum expected values.

On the other hand, the user or contractor may dictate a scale range consistent with the power of the generator or other equipment to which the wattmeter is connected. This value may differ considerably from that obtained by computation from maximum current and voltage circuit ratings. Thus, in order to calibrate or check a wattmeter, the relations of scale, potential transformer ratios, and current transformer ratios must be established.

Secondly, it must be made clear that practically all wattmeters, whether single phase or polyphase, are calibrated on single-phase circuits. The term "Calibrating Watts" then is an abbreviated form of "single-phase watts in calibration" and represents the single-phase power which must be applied to any wattmeter or varmeter having all current coils in series and all potential coils in multiple to obtain full-scale ratings.

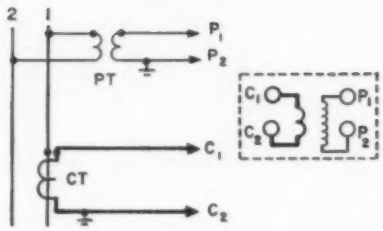
$$\text{Calibrating Watts} = \frac{\text{Scale in Watts}}{\text{PT Ratio} \times \text{CT Ratio} \times K}$$

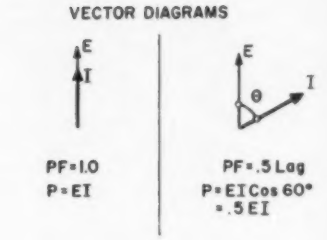
Where K = 1 for standard single-phase wattmeters; K = 2 for 2-element, 3-phase, 3-wire wattmeters used in the normal manner; and K = 4 for 3-current coil — 2-potential coil wattmeters used on 4-wire, 3-phase circuits. Note also that the factor K will vary for special applications to take into account unusual phase relations, multiplying factors, etc, so that values on the diagrams must be followed carefully for unusual applications.

Perhaps the greatest "mystery" exists in 4-wire, 3-phase instruments of the 3-current coil construction. The question is often asked, "Why is the value of K equal to 4 rather than 3?" During single-phase calibration at unity power factor, the current in all coils is in phase with the voltage, while in the actual 4-wire, 3-phase application, the two crossed current coils in the number 2 phase each operate at one-half torque due to the 60-degree phase angle between this current and its two related potentials. Thus, the torque during single-phase calibration is actually 4/3 the normal value on the 4-wire, 3-phase circuit and accounts for the value of 4 in the formula.

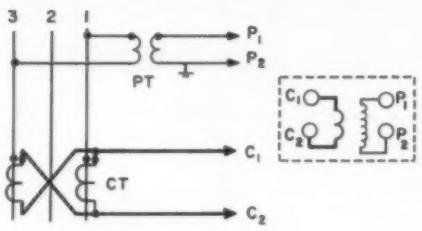
The second half of this article will continue the discussion on connections, and will include the remainder of 22 different connection diagrams. Watch for it in a future issue of POWER ENGINEERING. THE END

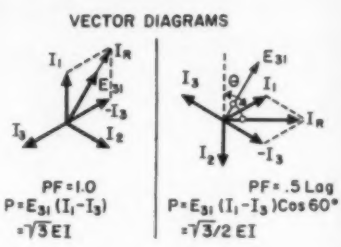
1 **Metering:**
Watts on single-phase, two-wire circuit
Transformers:
1 potential, 1 current trans.
Instrument:
Single-element wattmeter
Special Features:
None
Limitations:
None. Standard connection
Cal. Watts = Scale in watts / P.T. Ratio x C.T. Ratio



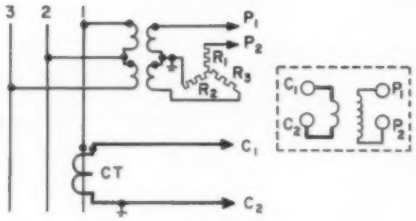


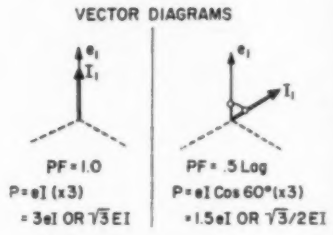
2 **Metering:**
Watts on 3-phase, 3-wire circuit
Transformers:
1 potential, 2 current trans.
Instrument:
Single-element wattmeter
Special Features:
8.66 ampere current coil
Limitations:
Balanced Currents and voltages
Cal. Watts = Scale in watts / P.T. Ratio x C.T. Ratio



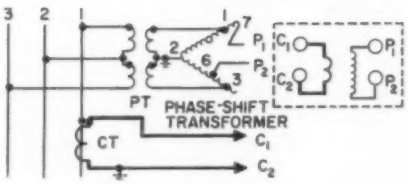


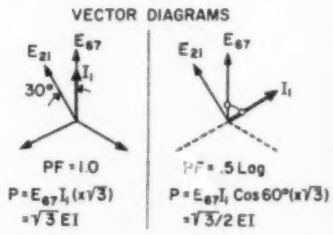
3 **Metering:**
Watts on 3-phase, 3-wire circuit
Transformers:
2 potential, 1 current trans.
Instrument:
Single-element wattmeter
Special Features:
69-volt winding, resistance Y-box
Limitations:
Balanced currents and voltages
Cal. Watts = Scale in watts / P.T. Ratio x C.T. Ratio x 3



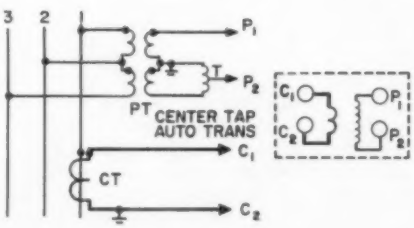


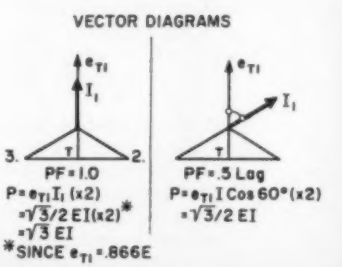
4 **Metering:**
Watts on 3-phase, 3-wire circuit
Transformers:
2 potential, 1 current, and phase-shift transformers
Instrument:
Single-element wattmeter
Special Features:
Calibration only
Limitations:
Balanced currents and voltages
Cal. Watts = Scale in watts / P.T. Ratio x C.T. Ratio x √3





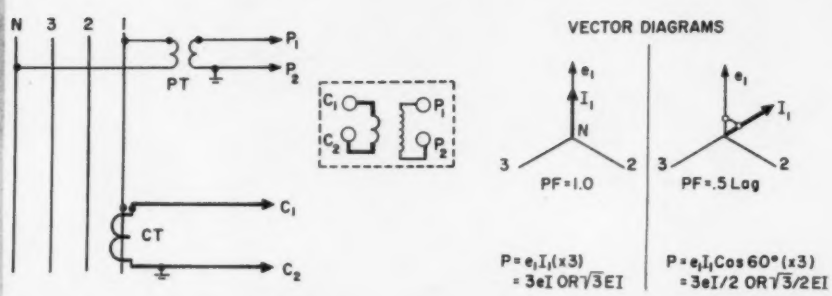
5 **Metering:**
Watts on 3-phase, 3-wire circuit
Transformers:
2 potential, 1 current and autotransformer
Instrument:
Single-element wattmeter
Special Features:
Calibration only
Limitations:
Balanced currents and voltages
Cal. Watts = Scale in watts / P.T. Ratio x C.T. Ratio x 2





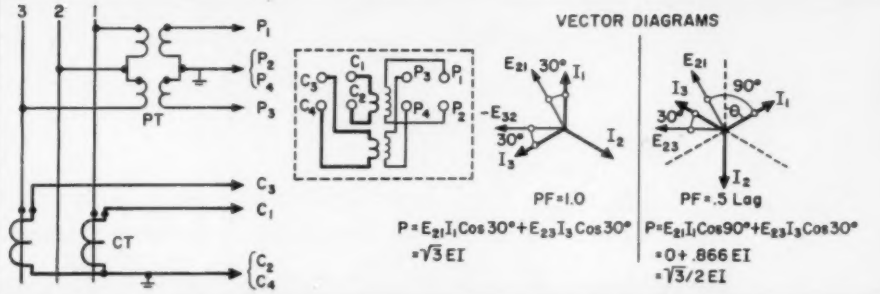
6 Metering:
Watts on 3 phase 4 wire circuit
Transformers:
1 potential, 1 current trans.
Instrument:
Single-element wattmeter
Special Features:
Calibration only
Limitations:
Balanced currents and voltages
Cal. Watts =Scale in watts

$$\frac{\text{Scale in watts}}{\text{P.T. Ratio} \times \text{C.T. Ratio} \times 3}$$



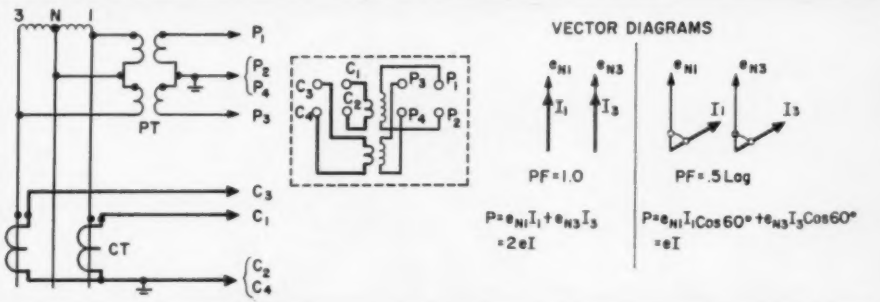
7 Metering:
Watts on 3-phase, 3-wire circuit
Transformers:
2 potential, 2 current trans.
Instrument:
2-Element wattmeter
Special Features:
None
Limitations:
None. Standard connection
Cal. Watts =Scale in watts

$$\frac{\text{Scale in watts}}{\text{P.T. Ratio} \times \text{C.T. Ratio} \times 2}$$



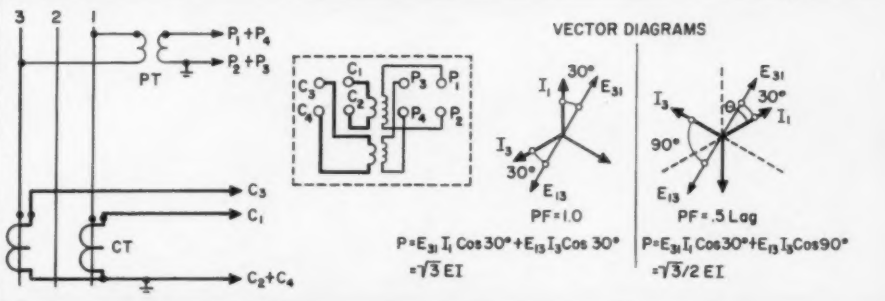
8 Metering:
Watts on single-phase, 3-wire circuit
Transformers:
2 potential, 2 current trans.
Instrument:
2-Element wattmeter
Special Features:
None
Limitations:
None. Standard connection
Cal. Watts =Scale in watts

$$\frac{\text{Scale in watts}}{\text{P.T. Ratio} \times \text{C.T. Ratio} \times 2}$$



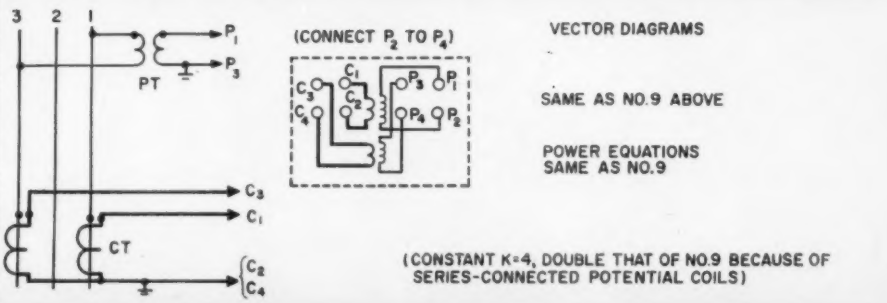
9 Metering:
Watts on 3-phase, 3-wire circuit
Transformers:
1 potential, 2 current trans.
Instrument:
2-Element wattmeter
Special Features:
None
Limitations:
Balanced voltages
Cal. Watts =Scale in watts

$$\frac{\text{Scale in watts}}{\text{P.T. Ratio} \times \text{C.T. Ratio} \times 2}$$



10 Metering:
Watts on 3-phase, 3-wire circuit
Transformers:
1 potential, 2 current trans.
Instrument:
2-Element wattmeter
Special Features:
Special calibration; potential coils in series
Limitations:
Balanced voltages
Cal. Watts =Scale in watts

$$\frac{\text{Scale in watts}}{\text{P.T. Ratio} \times \text{C.T. Ratio} \times 4}$$



WHAT DO YOU START WITH?

EARLE M. SOMMERFIELD, OF UNITED ENGINEERS AND CONSTRUCTORS, INC, PROVIDES A MOST ENLIGHTENING SUMMARY OF MOTOR STARTER NEEDS FOR TYPICAL STEAM POWER PLANTS

RELIABLE plant operation is obviously impossible without dependable motor controllers. But how many of us have attempted to make a detailed listing of the size and type of each and every starter in a fair sized power plant? It is rather surprising to find that almost 200 motors are used in a modern station, each of which requires some kind of a starter.

Controller selection demands intimate knowledge of the motor to be controlled, of the equipment to be driven by the motor, of the location to be used, and of the electrical distribution system.

NEMA IC Standards identify contactor sizes by corresponding 8-hour (considered continuous) current-carrying capacity. On the basis of interrupting capacity, maximum horsepower rating is also listed.

Low-voltage contactors cannot be used when motor line voltages exceed 600 volts. Motor controllers with high-voltage contactors may be used for circuits up to 5000 volts. Above this voltage, circuit breakers and switchgear equipment must be used.

Study of a typical 75-Mw and a 150-Mw unit show, respectively, a total of 189 and 195 motor starters. Motor horsepowers range from 1/6 to 1500 for the 75-Mw unit, and from 1/4 to 3000 for the 150-Mw unit.

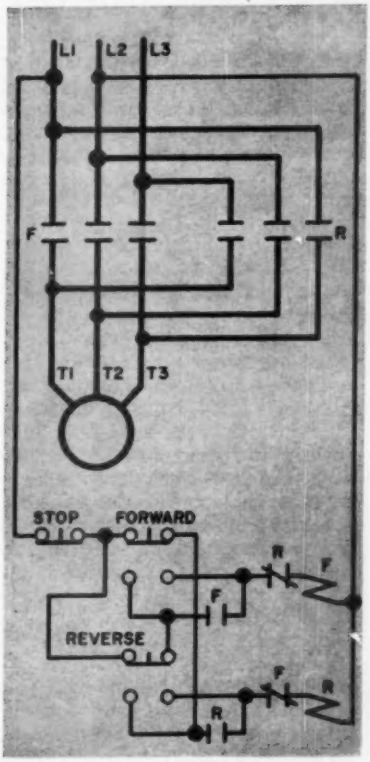
Application of each starter for the 150-Mw unit is given in the table, together with motor horsepower and size of circuit breaker or starter.

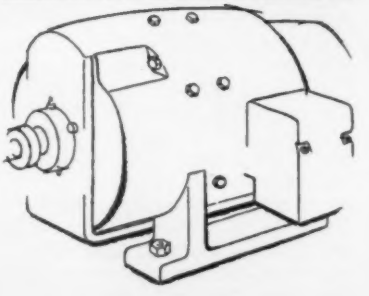
Motor Starter List, Typical Steam Power Plant, 150-Mw Unit

Service	Quantity	HP	Voltage	Circuit Breaker or Starter Size
BOILER HOUSE:				
Boiler Feed Pump	2	3000	4160	(CB) 50-DH-250
I. D. Fan	2	1500	4160	(CB) 50-DH-250
F. D. Fan	2	700	4160	(CB) 50-DH-250
Coal Mill	4	350	4160	(CB) 50-DH-250
Coal Scale	4	1	480	1—NRFV
Coal Feeder	4	1	480	1—NRFV
Air Preheater Circ. Oil Pump	2	¾	480	MS
Air Preheater	2	10	480	2—NRFV
B.F.P. Aux. Oil Pump	2	½	480	1—NRFV
Boiler Circ. Water Pump	3	300	4160	CB
Boiler Circ. Water Valves	3	5	480	1—Rev
Soot Blower Compressor	2	300	480	APCB
Air Preheater Cooling Fan	2	¼	480	MS
F. D. Fan Blower	2	½	480	1—NRFV
Light Oil Pump	2	7½	480	2—NRFV
Ignition Torch Air Fan	8	2	480	2—NRFV*
TURBINE ROOM:				
Spare Exciter	1	1100	4160	CB
Lube Oil Transfer Pump	1	5	480	1—NRFV
Turbine Lube Oil Filter Circ. Pump	1	¾	480	1—NRFV
Seal Oil Supply Vacuum Pump	1	2	480	1—NRFV
Main Seal Oil Pump	1	7½	480	1—NRFV
Turbine Oil Vapor Extractor	1	3	480	1—NRFV
Turbine Aux. Oil Pump	1	150	480	APCB
Gland Condenser Exhauster	2	5	480	1—NRFV
Turning Gear Drive	1	10	480	2—NRFV
Turning Gear Aux. Oil Pump	1	15	480	2—NRFV
Emergency Bearing Oil Pump	1	15	480	2—RV
Emergency Seal Oil Pump	1	5	480	1—RV
Stator Oil Cooling Pump	2	40	480	3—NRFV
Stator Oil Vacuum Pump	2	½	480	1—NRFV
Aux. Detraining Vent Blower	1	½	480	1—NRFV
Exciter Swgr. Amplidyne	1	20	480	ACB, 3 P, 70 A
Turbine Room Crane:				
Main Hoist	2	50	480	ACB, 3 P, 225 A
Trolley	1	10	480	
Aux. Hoist	1	30	480	
Swgr. Room Vent Fan	1	5	480	1—NRFV
Drain Sump Pump	1	¾	480	1—NRFV
CONDENSING:				
Circulating Water Pump	2	500	4160	CB
Condensate Pump	2	450	4160	CB
Traveling Screen	2	1¼	480	1—Rev
Circ. Water Pump Valve	10	1	480	1—Rev
Strainer	2	¼	480	1—NRFV
Condenser Vacuum Pump	1	60	480	4—NRFV

Service	Quantity	HP	Voltage	Circuit Breaker or Starter Size
WATER TREATMENT:				
Phosphate Pump	1	7½	480	1—NRFV
Chemical Mixer	2	½	480	1—NRFV
Chemical Waste Sump Pump	2	½	480	1—NRFV
Salt Conveyor	1	1½	480	Drum Controller
Evaporator Feed Pump	2	1½	480	1—NRFV
COAL AND ASH HANDLING:				
Ash Sluice Pump	2	200	480	5—NRFV
Conveyor Drive	1	50	480	4—NRFV
Tripper	1	5	480	1—NRFV
Coal Sampling Cutter	1	3	480	1—NRFV
Coal Crusher	1	300	480	CB, DB—25
Coal Conveyor	1	40	480	4—NRFV
Stockout Conveyor	2	50	480	4—NRFV
Magnetic Sep. Conveyor	1	3	480	1—NRFV
Clinker Grinder	1	5	480	1—NRFV
Barge Unloading Feeder	1	3	480	1—NRFV
Reclaiming Pit Feeder	2	5	480	1—NRFV
Conveyor Stacker	1	20	480	3—NRFV
Stacker Telescoping Chute	1	7½	480	1—Rev
Conveyor Drive	1	100	480	5—NRFV
Bunker Conveyor	1	20	480	3—NRFV
Reclaiming Pit Sump Pump	2	1	480	1—NRFV
Dust Control Solution Pump	1	2	480	1—NRFV
Transfer Weigh Chain Drive	1	½	480	MS
Aux. Hoist Rotation	1	5	480	1—Rev
Barge Pullers	4	10	480	ACB, 3 P, 100 A
Coal Barge Capstan	1	10	480	2—NRFV
Coal Unloader, Aux. Hoist	1	20	480	2—NRFV
Coal Barge Unloader:				
Hoist	1	300	480	6—Rev
Bucket Close	1	125	480	5—Rev
Trolley	1	100	480	4—Rev
PLANT SERVICES:				
Weld Area Exhaust Fan	1	1	480	MS
Office Air Conditioning:				
Exhaust Fan	1	3	480	1—NRFV
Compressor	2	50	480	3—NRFV
Fan	1	15	480	2—NRFV
Cond. Pump	2	2	480	2—NRFV
Station Air Compressor	1	75	480	APCB
Instrument Air Compressor	2	30	480	3—NRFV
Bearing Cooling Water Pump	2	75	480	APCB
Roof Vent Fan	4	5	480	ACB, 3 P, 50 A
Boiler House Vent Fan	6	25	480	2—NRFV
Elevator: MG Set	1	20	480	ACB, 3 P, 70 A
Vent Fan	1	½	480	
Sump Pump Chemical Waste	2	½	480	1—NRFV
Control Room Air Conditioning:				
Compressor	1	15	480	2—NRFV
Supply Fan	1	2	480	1—NRFV
Recirc. Fan	1	1	480	1—NRFV
Vacuum Cleaning System	1	20	480	2—NRFV
Battery Charging MG Set	1	15	480	2—NRFV
Roof Vent Fan	4	½	480	MS
Machine Room Blower	1	5	480	1—NRFV
Aux. Repair Hoist	1	5	480	ACB, 3 P, 50 A
Battery Charger	1	7½	480	2—NRFV
City Water Booster Pump	2	20	480	2—NRFV
Shop Crane: Trolley	1	2	480	ACB, 3 P, 70 A
Bridge	1	5	480	
Hoist	1	15	480	
Chilled Water Circ. Pump	2	3	480	1—NRFV
Unit Heaters	2	2	480	ACB, 3 P, 40 A
Sump Pump	2	10	480	2—NRFV
Wall Exhaust Fan	2	15	480	2—NRFV
Spot Cooling Fan	2	3	480	1—NRFV
Elevator	1	10	480	ACB, 3 P, 50 A
Yard Vac. Cleaning System	1	25	480	2—NRFV
Shop Air Compressor	1	10	480	ACB, 3 P, 50 A
Bearing Water Pump Filter	2	¼	480	1—NRFV
Turbine Rm. Roof Exh. Fan	3	3	480	ACB, 3 P, 50 A
Boiler Room Roof Exh. Fan	4	5	480	ACB, 3 P, 50 A

ACB = Air Circuit Breaker
CB = Circuit Breaker
RV = Reduced Voltage Starter
APCB = Air Power Circuit Breaker
Rev = Reversing
MS = Manual Starter
NRFV = Non-Reversing Full Voltage
* = Controls all 8 Fans





HOW TO KEEP STEAM CONDENSERS OPERATING EFFICIENTLY

BY R. A. WILSON, THERMAL POWER DEPT, ALLIS-CHALMERS MANUFACTURING CO

ONE OF THE PROBLEMS in keeping the condenser tube heat transfer surfaces clean on the water side is the accumulation of algae and slime. The surfaces where they live become slimy and sticky, which makes it possible for them to remove and hold clay particles, bits of sand, and organic matter. It appears that the substances which stick to the slimy surfaces produced by these organisms are used to form their food supply.

In general, deposits can be controlled by chlorine. Acid cleaning is not a solution to the problem. Rubber plugs can be shot through condenser tubes using compressed air at about 90 psi with one of the standard guns available. Slime can also be controlled by drying out and heating.

Algae and Slime Control

Best treatment for slime deposits is largely a preventive treatment to discourage the growth of slime or periodically destroying it before a thick deposit forms. If slime is allowed to grow and build a deposit of foreign matter on the tube surface for many months (for example during a winter), this deposit cannot be removed by slime control methods. Slime control can only control the rate of accumulation of new deposit. The old deposit can only be removed mechanically, or by a combination of chemical and mechanical means. Chlorine is not effective against old tube deposits.

When controlling slime with chlorine in systems with cooling towers, a chlorine residual may be established by feeding chlorine in at the suction of the circulating water pumps. Experimentation will establish feeding rates.

Redwood cooling towers have reportedly been damaged by excessive chlorine residuals. Consideration should be given to this and the concentrations controlled.

In general, the slimes, algae and fungi are all damaged by the same chemicals. Numerous algaecides are used and some have been available less than ten years. Sodium pentachlorophenate is well known for this use. Copper compounds have been used, but copper sulphate can cause corrosion of metals in the piping and should be controlled. The judicious periodic use of different agents for the control of algae, slimes and fungi is probably desirable and in some cases necessary.

In using the natural sources of water on a once-through system, the chief method of controlling slime has been to use either chlorine or some of the chlorine compounds fed on a slug basis.

Adding Chlorine

In general, chlorine should be fed in short periods of ten minutes or less and in substantial amounts to produce at least one-half part per million chlorine residual at the condenser outlet. Thus, in sizing feeders the chlorine demand should not be underestimated. Also, the frequency at which chlorine should be added will normally be oftener in summer when the slime grows fast, than in winter.

An alternate method of adding chlorine, which applies particularly to small condensers, is to make chlorine-bearing powder into a slurry and put this in the suction of the circulating water pump. A feeder, with pressure from the discharge of the circulating pump on one end of a closed tank that contains the chlorine-bearing slurry and suction pressure on the other end, may be used even on some very large units.

Some of these powders contain chlorine with an effective germicidal action equivalent to 0.7 of a pound of liquid chlorine in each pound of powder. The effective chlorination cost using powder will probably be several times as high as using liquid. Powders do not require expensive apparatus to use and present little hazard around a plant.

However, these powders are strong oxidizing agents and should be handled as such. The chlorine-bearing powder can be mixed up and fed into the system by the normal operators and requires less supervision by instrument men and chemists than does the more complicated liquid chlorine control apparatus.

Another method of adding chlorine is to use a chlorine bleach solution. This will definitely cost more than liquid chlorine, but the feeding apparatus will be simpler and cheaper and will cost considerably less than the chlorine-bearing powders. Using this method of adding chlorine will perhaps increase the operating cost, but it can reduce the fixed cost of equipment considerably.

Preferred method of using chlorine is with good chlorine feeders using liquid chlorine. These alternate methods may be used if present feeding systems are inadequate. Other methods could be used to give some supplemental feedings to help clean out a condenser which is not being kept clean by regular equipment. These are also a check on how well chlorine requirements are being met and perhaps will indicate the need of more chlorine-feeding equipment.

In the case of long suction tunnels from a screen house to a plant where the circulating water pumps are at the condenser, the chlorine feed should go in at the pump suctions. Each unit can be chlorinated separately from a single chlorinator. This applies to units where mussels and marine growth are not a factor and where there's no problem in keeping the circulating water tunnels reasonably clean without the use of chlorine.

Evaluating Results

Evaluating the effect of chlorination equipment is rather complicated. To check the effectiveness of slime control, the outlet ends of the tubes and, in the case of a two-pass condenser the outlet ends of the second pass, should be inspected.

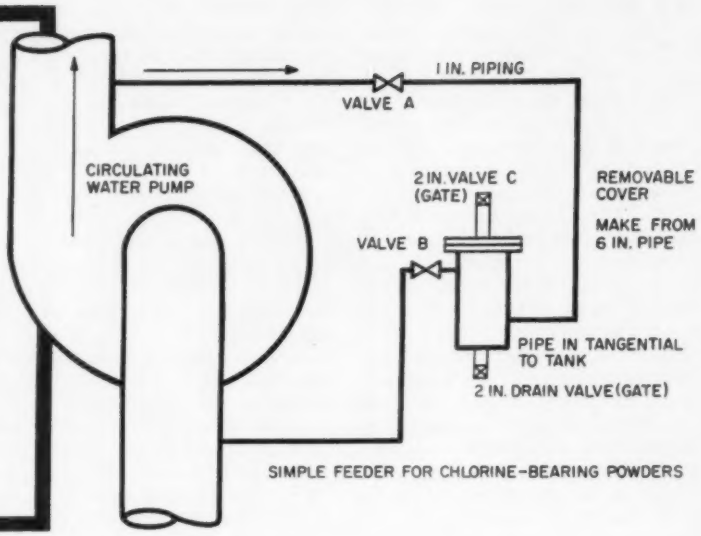
Inspection of the outlet ends is emphasized because the turbulence and the erosion at the inlet end of tubes frequently prevent slime from forming there. The outlet ends of the tubes are approximately 15 F warmer than the inlet ends, causing slime to multiply faster at that location. Also, any rubbish or suspended matter in the water will tend to keep the slime un-

TYPICAL METHOD OF OPERATION

Feeding periods—approximately five minutes at two-hour interval or as required. Dosage of chlorine 3 to 5 ppm of water pumped.

Procedure

1. Close valves A and B.
2. Drain water slightly using drain valve and valve C.
3. Add chlorine-bearing powder through valve C (or remove cover, add powder, mix and replace cover).
4. Close valve C and drain valve.
5. Open valve A and B.
6. After dosing period close valve A.



SIMPLE FEEDER FOR CHLORINE-BEARING POWDERS

der control in the turbulence at the inlet end much better than at the outlet end.

The evaluation is further complicated because many natural waters may at certain times contain enough sand and gravel and other such rubbish to polish out slime that has not been on the tubes too long. This happens on many rivers during the normal spring floods. Thus, it is hard for a chemist, or a results man who checks the effectiveness of chlorination occasionally, to find out what is happening to the unit.

After a flood it may appear advisable to eliminate all chlorine feed or cut it down tremendously. Just before the flood and after a long period of fairly stagnant operation during the summer months, it may appear advisable to use much more chlorination than is available.

Drying Out and Heating

Slime can be controlled by drying out and heating. Fans may be installed on the water box covers so that when the unit goes down and the condenser is drained the manhole doors may be opened, the fan positioned, and air blown through the condensers to dry the inside of the tubes. After the material in the tubes is dried out it shrinks tremendously and tends to curl up. The living organism appears to be dormant and can be washed away when the water flow is re-established.

This drying process can be speeded up if the condenser steam space is filled with warm water or is kept warm by some other means while air is circulated through the tubes.

It should also be noted that keeping a condenser clean and free from slime has merit from the standpoint of corrosion as well as from the standpoint of heat transfer. With an extremely dirty condenser and heavy slime deposit corrosion may occur due to formation of ammonia by decomposition of organic matter during an outage.

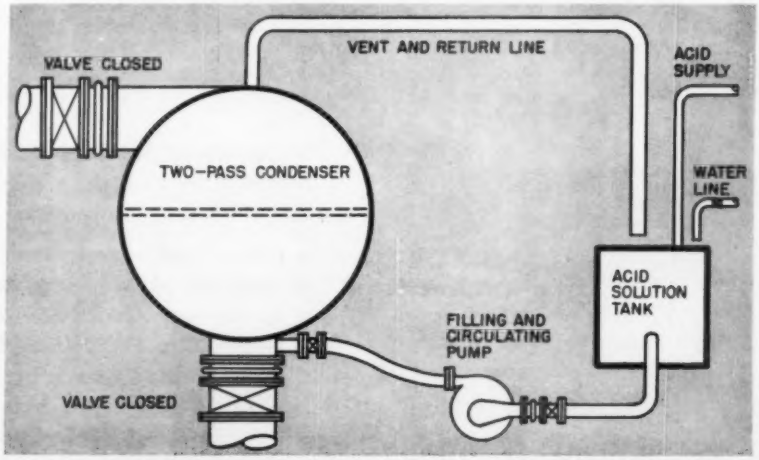
During part of the year many of the natural waters deposit calcium carbonate as a scale in the condenser even though, strangely enough, they may remove some of it during part of the year.

Acid cleaning can be applied here because it is needed the most and shows up the best with a heavy calcium carbonate scale. The scale should be removed entirely by acid but in practice there is usually foreign matter associated with this, and it will remain loose in the tubes after the body of the scale is removed. It pays to remove this before considering the job finished. Thus, in many cases the acid cleaning should be followed by plugs to remove the rubbish that is left. A scraper plug using high-pressure water is an ideal solution for this, or a nylon brush might also be satisfactory.

Although effective for calcium carbonate scales, in general, acid is not an inexpensive or particularly effective method of removing heavy slimes and the deposits associated with slime coatings. It must be recognized that none of the acids will dissolve carbon particles. They are very ineffective in dissolving sand and clay and other such suspended matter but may do a good job on the binder. The acids are generally not particularly effective in removing iron ore and heavy deposits of iron oxide.

Before attempting to clean a condenser with an acid or any cleaning solution, the effectiveness of the cleaning solution should be demonstrated on a sample tube in the laboratory.

A schematic arrangement for acid cleaning the steam condenser



Acid used for calcium carbonate should be hydrochloric acid. A number of good inhibitors available for hydrochloric acid help to cut down the corrosion of the metal and do not inhibit to a great extent the action on the dirt to be removed. Sulfuric acid would not be desirable since calcium sulfate is insoluble. However, any kind of acid may be harmful for units with packed tubes, since if acid soaks into the tube packing it will tend to stay there and act over a period of time, causing pitting and corrosion of the tubes in this area.

Before attempting any chemical cleaning, venting of the condenser should be provided and adequate time allowed. A small hose is not an adequate vent during chemical cleaning. Hydrogen is formed as a by-product of the attack of acid on the metal. Carbon dioxide is involved in large quantities when calcium carbonate is dissolved by acid. Tremendously high pressures can be developed if these gases are not released by proper venting. Also the gases must be properly vented or the heat transfer surface will not be wet completely with acid.

Caution: the gases vented off from the spaces that are being chemically cleaned should be considered explosive and treated accordingly. There was one well-publicized case several years ago in which cleaning was being done on a condenser which had leaky tubes. The acid spread to the steam side and apparently generated some hydrogen which exploded and practically wrecked a condenser and a turbine.

A suggestion made since then is that whenever possible the steam side of a condenser should be flooded during acid cleaning. This would tend to dilute any acid that got into the steam space. Furthermore, if the water is higher in the steam space than in the water space, the flow would tend to go from the steam side to the water side in case there is a leaky tube.

Since the acid that would normally be in a tube may be very inadequate to remove the scale that is in the tube, the acid should be recirculated slowly to help vent out the gases and to mix up that in the large water boxes with that in the tubes, so that all of it is used to its best advantage. This is a necessary requirement for successful cleaning of surface condensers.

After the condenser has had the acid for a time, the acid should be titrated to determine if the strength has been spent. A new charge of acid may be necessary. The cleaning should proceed until there is a residual of active acid that is not being used for a period of time. Continuous titration of the acid should indicate when the job is finished.

Hydrochloric acid used with inhibitors in boilers is not circulated because the acid after aeration is quite aggressive to steel when the acid is flowing. In the case of boiler tubes, the acid in the tube may be adequate to remove the scale, which normally is not a calcium carbonate deposit.

There is considerable evidence that properly inhibited hydrochloric acid can be circulated in condensers that are fairly clean without any damage to the tubes. There is apt to be more damage to the steel parts and particularly to steel piping used in the vicinity of the acid pump. Highly aerated acid with abrasive sand and scale that might be loosened and carried along could be quite corrosive to the piping and the pump.

In the case of water boxes with zinc plates it is well to remove the plates before acid cleaning or to cover them with a grease compound to prevent acid containing considerable copper from the tubes from coming in contact with the zinc.

When Is a Condenser Clean?

Although hydrochloric acid is generally hazardous to stainless steel tubes, some inhibitors available are supposed to protect the stainless. However, particular care should be taken in acid cleaning a condenser that has stainless steel tubes or stainless steel expansion joints.

A condenser is clean only when it has been found to be clean by very careful inspection. It is easy to be fooled by a condenser with a heavy calcium carbonate scale, because a rather thick egg-shell-like scale can be left that looks quite similar to the tube material.

One suggestion is that the inside of the tubes be measured by calipers at the ends, or rubber or steel scraper plugs be put through the tubes. If these get stuck it is a clue that the condenser has not been cleaned.

In some cases wooden spools have been turned to different diameters to go into the tubes to determine the presence and extent of scale. This is valuable information to have and also to give to the man who is calculating the acid before the cleaning operation starts.

Steam Side Cleaning

The question has arisen as to the effectiveness of steam side cleaning of a condenser. Some condensers have been cleaned with hydrochloric acid on the steam side, but they were also cleaned on the water side about the same time. This made it impossible properly to evaluate the effectiveness of the cleaning on the steam side.

Sulfuric acid has been used on both sides also. This combined cleaning did a lot of good and the tubes on the steam side appeared to be cleaned effectively, but it has been debatable as to the good that the steam side cleaning actually did.

There are some reports of very good results with steam side acid cleaning. There will be more acid cleaning of condensers on the steam side than there has been in the past. An alkaline solution would be preferable to hydrochloric acid for reasons similar to those mentioned above.

Hydrochloric acid will give off vapors which will corrode the steel parts of the turbine and the condenser above the acid line. These vapors can also attack stainless steel expansion joints in extraction heater lines and wherever else stainless steel might be present in the condenser. For this reason sulfuric acid is preferable for steam side cleaning. THE END

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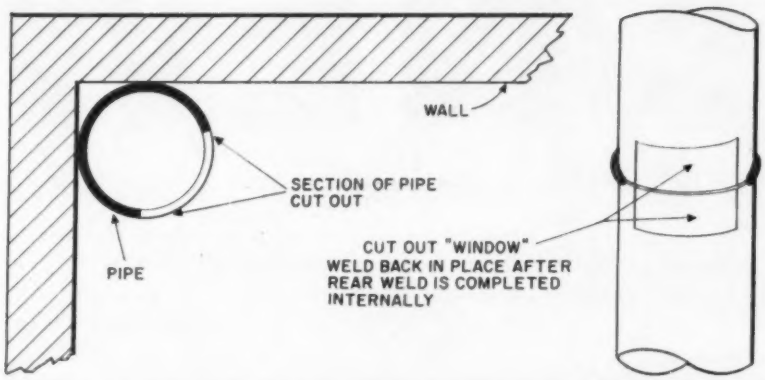
This article is the seventh and last in a series on the condenser, authored by experts at Allis-Chalmers. We plan to reprint the set, which covers these subjects:

- Choosing Condensers Economically
- Methods of Checking Steam Condenser Performance
- Condenser Air-Removal Equipment
- Controlling Steam Side Erosion of Condenser Tubes
- What Causes Corrosion in the Condenser Steam Space?
- Backwashing the Condenser
- How to Keep Steam Condensers Operating Efficiently

Power Engineering HANDBOOK



Welding-in That Corner Pipe

By N. R. SMALL

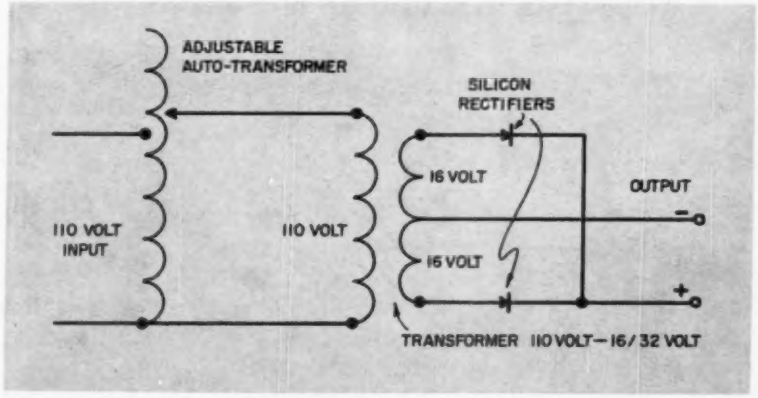
HAVE TO INSTALL a pipe in a corner where the back of it can't be welded? Use a window weld, as shown in the sketch.

New D-C Device Saves Maintenance Money

By W. STEWART ANDERSON,
Westinghouse Electric Corp, in the company's *Maintenance News.*

AN EASTERN RAILROAD has put in operation a device which can save time and money. They have been using a large motor generator set to give them dc for testing traction motors — flashing fields — polarizing fields and reading bar to bar on armatures. This M-G set is turned on in the morning and turned off at night even though it may be used only 10 or 12 times a day. The reason for the continuous operation was that the start-up costs more money, especially if done a dozen times a day. The device to eliminate this M-G set is very simple.

Using an old welder transformer rated 110 volts primary and 16/32 volts secondary, they installed a Variac attached to the primary to control the voltage. They bought two number 302F rectifier cells rated 35 amp each and placed one each in the outside secondary legs and then tied them together. By using the center tap of the transformer which is a negative they obtained full wave rectification. (See sketch.) For test purposes they have obtained over 100-amp output from the rectifiers. While this is not advisable from 35-amp rectifier cells, the trick is to dissipate the heat. This has been done by threading them in a copper plate.



However, with rectifier cells of a larger size any desirable amperage can be obtained.

Since no current is used when this device is unloaded, the saving over an M-G set that either start-stops or runs all day is considerable. An extra plus feature is the mobility of the unit. Instead of taking wires all over the shop this unit can be moved to the nearest wall plug and then be put into use.

Now... a completely self-cased, MODULAR BOILER

C-E's NEW

DESIGN HIGHLIGHTS OF THE VU-60

Modular construction makes it possible to assemble custom designs from standardized components.

Boiler can be proportioned for best combustion, heat absorption and gas flow even when space conditions are limited or difficult.

Completely self-cased, the VU-60 is an all-welded gas-tight and pressure-tight envelope of finned furnace and boiler tubes. This results in less non-working weight per pound of steam capacity.

No external ductwork. The bottom of the boiler is a plenum chamber which allows air to flow direct from the air heater to the burner windbox.

Number of field-welded pressure parts is greatly reduced.

Cross flow baffling and symmetrical boiler bank mean low draft loss, no sluggish gas flow in any pass.

Requires only a simple, reinforced concrete slab. No conventional roller supports required.

Paneled construction cuts erection time.

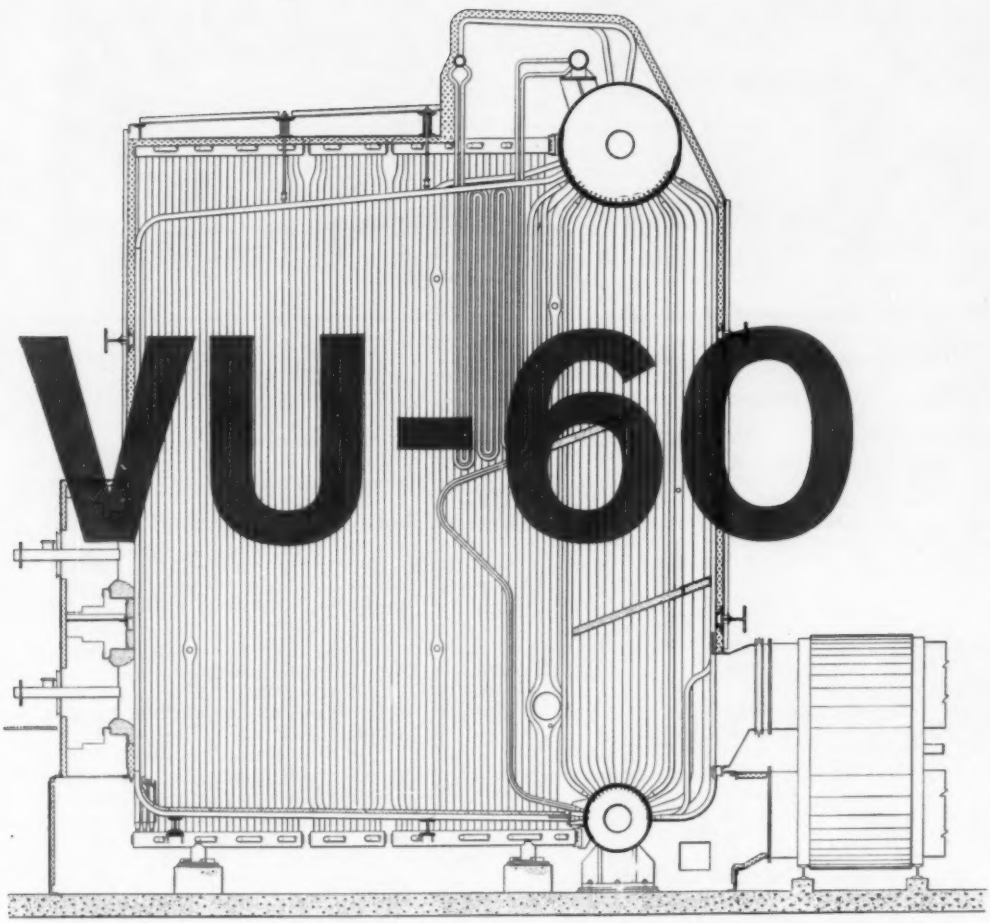
No air heater supporting steel is required.

For pressurized or induced draft firing. When pressurized, unit does not require induced draft fan.

VU-60 SPECIFICATIONS

Capacities:	100,000 to 250,000 lb per hr
Design pressures:	250, 500, 750, 1000 psi
Steam temperatures:	To 900 F
Fuels:	Oil and/or gas
Firing:	Horizontal (front wall) or tangential
Size increments:	Depth — twelve Width — eight Height — three
Steam drum sizes:	Four

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS;



The VU-60 Boiler is a new and logical extension of C-E's service-proved VU series. Like all VU units, it is completely integrated, symmetrical in design, uncluttered and uncomplicated. Based on a standardized modular concept, it offers greater flexibility, yet stays within the bounds of solid and proven practice.

The VU-60 is a functional boiler. Completely self-cased, the exterior walls of this unit (furnace and boiler) are composed of finned tubes, shop welded into panels. The fins between panels are field welded to form a gas- and pressure-tight structure. Insulation is applied directly to the outside of these walls and is covered by pre-formed, field installed metal lagging. Thus non-working weight and bulk is reduced to a minimum.

The VU-60 is economical, it is dependable, it is accessible. It is easy to install and will meet your most exacting steam needs. Why not write for further information, or, if you prefer, contact the C-E office nearest you.

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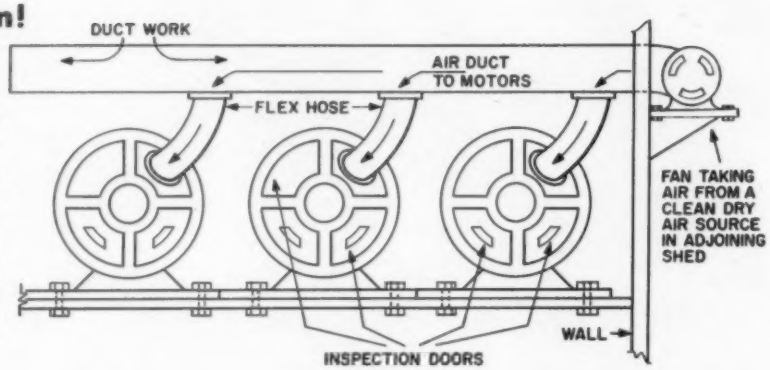
Keep Those Motors Clean!

By TOM MULLIN

DIRT, LINT and oil mist kept us busy constantly cleaning and maintaining three large motors used for induced draft, located in the upper fire room. So we made a duct, as shown in the sketch, cutting a hole in the wall for clean air inlet. We sealed up inspection plates except for two small screened holes. Then we connected flexible hose to the inspection doors, and ran the fan in the adjoining shed (see sketch), thus supplying clean air to the motors. Good results were obtained.



Dealing With That Broken Stoker Pin

By HERMAN A. LUDEWIG, Principal Sta. Engineer, Green Haven State Prison, Stormville, N. Y.

TOTAL RESISTANCE of the standard underfeed stoker, from rams to dump grates, plus that of the firebed, is centered on the safety-pin. This pin is usually a mild steel pin of ½-in. diam, or one of equal shearing strength. Any load exceeding that of normal operation will shear off this pin and stop fuel feed and tuyère motion.

In a new stoker this may occur due to rubbing action of the tuyère supports against one other, chiefly at the shoes, or against the seal plates, after they have operated satisfactorily in a cold state. The whole overfeed section may have expanded and the space allotted to it is now not quite enough. Side-bars, even new ones, are or become warped at times, causing pin breakage. The trouble center is usually at the top, and it becomes necessary to take these side-bars out and plane them down ⅛-in. to ¼ in. at both ends, to give sufficient clearance between them and the chute sides.

If the stoker has been run empty for several days, most of these inequities may be discovered and eliminated by judicious use of the cutting-torch. There should be a ⅛-in. clearance between the side-bar-cap and the top of the side-bar. If this is not present, it may be obtained by jacking up the cap slightly and inserting shims, such as old hacksaw blades, between the cap and the tops of the chute sides.

Excessive friction between rams and cylinder liners is often a cause for safety-pin breakage, usually due to careless installation of liners, resulting in protruding boltheads or misalignment.

After some wear has taken place, a hard glossy scale consisting of fines, iron oxide and a binder, may build up between ram and cylinder and cause enough resistance to break the crank-bearing cap on the outward stroke. For this reason oil, used on the rams, acting as a binder, should be discontinued. Better and cheaper, we think, is a strong wash out with water periodically, when the ram is on the "in" position. In extreme cases water may be piped to the cylinder tops and used as a steady lubricant there.

Most pin breakage, after causes due to metal faults have been overcome, is due to foreign objects in the cylinder or faulty firing. Since one can't tell which, off hand, the reason must be deduced. A second pin is installed on the chance that the obstacle has slid down, out of shearing position. Further pin breakage requires removal of the object.

If none is found, coking has probably taken place in the retort. The ram is now put in "out" position, and the space ahead of it is cleared of all coal. Bricks are now stacked up in the throat space for its full area and then pushed into the retort mouth by ram power. This process is repeated several times.

After the bricks (or wood blocks) are pushed in, coal is fed into the space vacated by them, by hand, for six or so revolutions. If all goes well, regular operation is taken up again. If the pin breaks before the wrist-pin engages the side-bar rods, the whole procedure is repeated and, to boot, the retort bottom is rodded out all the way back. This may be done with a ½-in. or ⅜-in. steel rod, about 15 ft long.

Occasionally, in stubborn cases, the water hose is turned directly into the plugged retort. This method may be open to argument, yet its effects often prove cathartic. If the fire is too heavy and green, it must first be burned down, or the above procedure is a waste of time.

Should the pin break on starting the grate motion, tuyères are most likely frozen to their neighbors. To find out which sides give trouble, the stroke adjuster on one side is put in "full stroke" position, the other in "minimum stroke." If no pin breakage occurs, the procedure is then reversed.

The troublesome side-bar and its neighbor are now made to go "in" together, just to see if the track is clear. Quite often this cures the trouble. If not, one side-bar is put in "full" travel, its neighbor in "minimum" travel. The stoker is slowed down to its absolute minimum speed. The safety-pin collar is pushed back and two pins, already sheared, the heads with about ½-in. of the shank remaining, are inserted in the pin hole. Considerably increased shearing resistance is obtained in this way.

A ½-in. wrought iron bolt also offers greater shearing strength, yet still safe, than the conventional soft rivets. This, plus the very slow stoker motion, will break the adhesions, if the condition is not bad enough to merit a shutdown anyway.

After an occurrence of this kind, regular inspection of the tuyères and side-bars becomes imperative. Extensive coke deposits within the side-bars indicate that another boiler should be made ready, as side-bar damage is likely to happen. If a heavy fire is carried in that particular firebox, the shutdown may be delayed for a week or so, yet vigilance must be exercised.

ONE OF A SERIES OF CHATS ABOUT CONSERVATION AND CONTROL OF HEAT

SARCO TOPICS

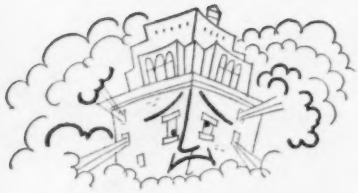
MODERNIZING A STEAM SYSTEM MEANS TRAPPING, TOO

Take an older building that has generated its own steam for decades and let's say it's switching to district steam. How can it take advantage of switch-over to rid itself of those classic symptoms of antiquated systems: trap maintenance at overtime rates, water-hammer, and live steam loss?

Well it just so happens a 17-story office building at 635 Madison Avenue, New York, recently did just that. Its steam system was overhauled; but recovery is now complete and it didn't hurt a bit.

First, let's look at the system as it was: Maintenance of the old system had to be done at overtime rates in off hours, because the system could not be shut down during business hours. There were frequent breakdowns. Passage of live steam into return lines when traps failed open not only wasted energy but caused water hammer, and when traps failed closed, water accumulated in steam supply mains and equipment.

The reason we give you this dreary picture is that it's so typical of old systems, and so easily fixed. The building management simply replaced bucket and float traps with Sarco Thermo-Dynamic Steam Traps, Type TD-50, matched and correctly sized to the application. And at the risk of sounding like a TV commercial, results were immediate: maintenance practically



zero, no water hammer, no loss of live steam, engine room crew free for other jobs. And, need we add, considerable savings.

We find it difficult to be modest about the TD-50 because it comes so close to being a cure-all. The facts are these: It has only one moving part, a stainless steel disc; it shuts off *positively*, so no steam can be lost; it discharges condensate as rapidly as it is formed; its pressure range of 10-600 psi makes it possible to standardize on one steam trap for a variety of applications that formerly required traps of many types and ratings.

Funny thing is, the TD-50 is so dog-gone *simple* and *small*, people find it hard to believe it does what it does. At 635 Madison Avenue, for example, changeover took only 30 minutes per trap, and trapping was accomplished with a few pounds and cubic inches of traps where hundreds of bulky pounds were needed before to do the job.

Write us for details, won't you? You've nothing to lose but your troubles, your waterhammer, and your worries.

HEATING COILS CAN CATCH COLD

Let's face it: even the best "non-freeze" air heating coils may freeze if they handle incoming air even slightly under 32°F. and aren't drained properly. Let's face it again: It's *not* inadequate steam trapping capacity that's most usually to blame. We don't mean to belabor the point, but if trap inlet pressure falls lower than trap outlet pressure, condensate *is* going to collect in the coil. And it's *bound* to freeze below 32°F. Take a preheat coil designed to heat air from 0°F. to 50°F. using steam at a maximum pressure of 10 psig. As the outside air temperature rises above 0°F. heat demand decreases the temperature controller reduces the steam pressure to compensate for reduced heat demand, and you're ripe for ice cubes in your coil tubes.

At Sarco we firmly believe that practical help is much more useful than sympathy noises. We can tell you (if it happens to be *you* who are caught with your temperature down) of at least three cures for fatal drop in pressure differential. They're quite simple and we would show not the slightest hesitation about revealing them to you.

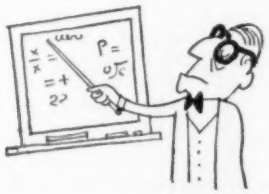
In fact, we'd also like to send you a master chart that enables you to check at a glance the danger point in handling outside air—an extremely useful piece of information—and a bulletin on Float-thermostatic steam traps.

It may hasten matters if, when you request this bundle of facts, you refer to the literature as Sarco Technical Bulletin No. T503.

MORE THAN ONE WAY TO TRAP STEAM

Just as there's no universal trapping application, there's no universal steam trap. The fact is that there are five basic steam traps in use today—and they're all rather thoroughly described in a rare monograph by Sarco engineers titled modestly and succinctly enough: Lecture 1A. You, personally, may not need a copy of this fundamental document, but wouldn't you like to know that your own people were up to date on steam trap basics?

It's easy to be sure this vital information gets into their hands: simply request a quantity of Lecture 1A and distribute copies as needed, with a little subtle persuasion that they be read. We can even arrange for a personal slide film lecture, followed by authoritative answers to trapping questions, if you can get an in-plant group together.



In any event, write to us. You may discover that a lot of progress is being made that isn't concerned with getting men to the moon.

Pardon our monopolizing the conversation in this series of paid communiques, but we're trying our best to interest you in certain subjects that concern us both—to the point where you'll communicate.

5108

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STEAM TRAPS • TEMPERATURE CONTROLLERS
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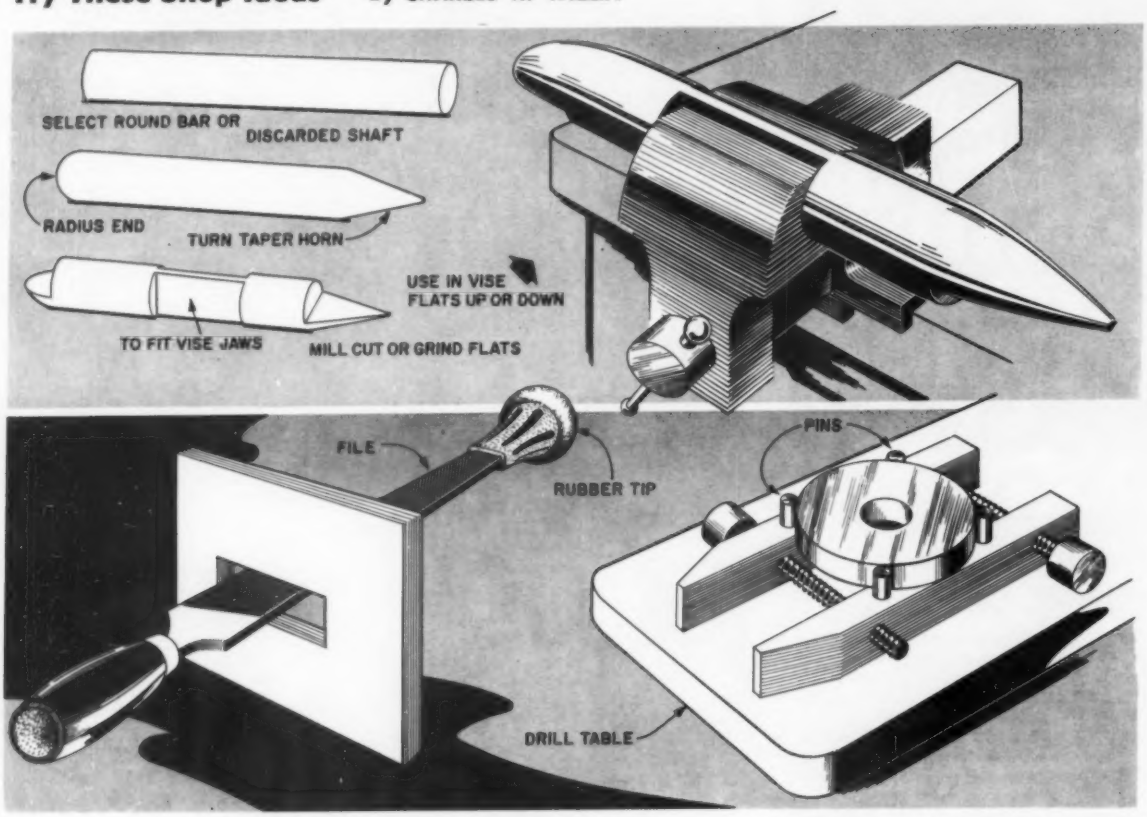
Try These Shop Ideas

By CHARLES H. WILLEY



OLD SHAFTS can be made into vise anvils which have many uses. The top sketch shows how such a discard can be salvaged and retained as a very handy item in the shop.

Sketch at right in lower panel shows how putting pins in your parallel clamp will enable it to hold a disc safely for drilling or other work.

Idea at left shows how a rubber tip for crutch or chair leg makes a good file grip and finger protector.

Finding Lost Timing in an Internal Combustion Engine

By GORDON LENAHAN Natural Gas Pipeline Co

HORRIBLE AS IT IS when it happens, the ignition systems of four-cycle stationary engines occasionally get wire crossed or someone forgets where all those wires were connected after overhauling the distributor, interrupter, timer, magneto or whatever it happens to be.

Of course, wire should be labeled, and care taken, but some ignition systems seem to be designed to trap the maintenance man. After these wires are all hooked up properly and the spark set in a safe position, the engine can be started and timed accurately.

This can be done very easily if the No. 1 cylinder is rolled to the dead center position, in which the inlet and exhaust valves are closed. The ignition cam is then set to fire No. 1 cylinder at that point. That is all there is to it. The rest is a matter of observing which lead the ignition cam next energizes and connecting it to the next cylinder in the firing order.

Two-cycle engines are easier. Since combustion occurs each time the flywheel makes a round, the No. 1 cylinder at top dead center is sufficient.

An ohmmeter can be used to determine the exact place where the points break; or if one is not available, the spot where a piece of cellophane from a cigarette pack is released by the points as they break, will do.

A subsequent check with a timing light should show that the engine is firing at top dead center. The timing can be advanced to the specified location at that time. Of course this last step can be made easier by allowing for the advance desired, earlier in the process, if this seems to be desirable.

In short, whenever proper ignition timing is in doubt, this simple and straightforward check is all that is required to eliminate the hazard of explosion during start-up of any spark-ignited engine.

Power Engineering HANDBOOK

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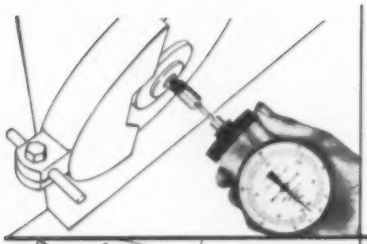
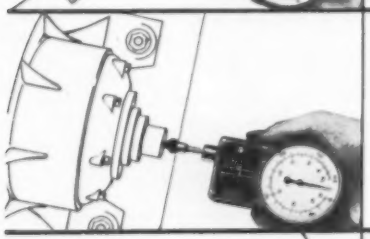
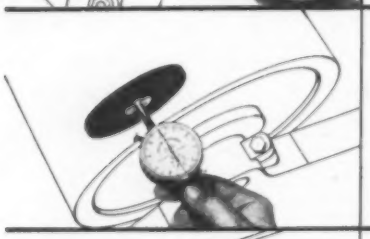


a **JAGABI® Centrifugal TACHOMETER** reads instantaneous speeds or variations in speeds up to 48,000 RPM. Single or multiple ranges.



DR. HORN TACHOMETER is a centrifugal type instrument with 6 ranges for checking speeds from 25 to 30,000 RPM.



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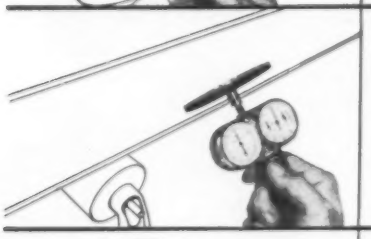
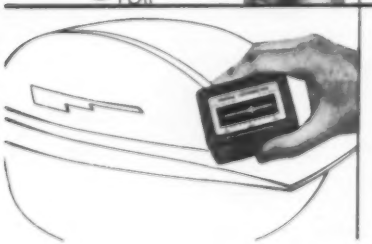


the **JAGABI® TACHOSCOPE**—a stop watch and revolution counter in one—gives average FPM and RPM up to 20,000.



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CONSTRUCTION NEWS

Birmingham, Ala. — Alabama Power Co, Alabama Power Co Bldg, this city, a subsidiary of the Southern Company, has authorized plans to sell $27,000,000 of securities this year to help meet its 1961 construction budget of $51,300,000. The financing package includes $13,000,000 of 30-year first mortgage bonds, $8,000,000 of preferred stock, and $6,000,000 of common. Balance of the company's 1961 construction outlays will be made up from internal sources and through short-term loans. Principal items include $18,500,000 for hydroelectric generating plants on the Coosa and Warrior rivers, and $26,000,000 for new transmission and distribution lines in the utility's trading area.

Anchorage, Alaska — City Council, City Hall, has been authorized by vote of citizens of Anchorage, Alaska, to arrange a bond issue of $2,025,000 for extensions and improvements in the municipal steam-electric generating station, with installation of a new gas turbine electric generating plant, boiler, and auxiliary equipment. Work will begin soon with completion scheduled for the fourth quarter of 1962. R. W. Beck & Associates, Seattle, Wash., is the consulting engineer.

Redding, Calif. — Bureau of Reclamation, Department of the Interior, Denver Federal Center, Denver, Colo., has announced contract award of $1,581,284 to the General Electric Co, 570 Lexington Ave, New York, N. Y., to furnish and install two 74,444-kva generators for the Clear Creek Power Plant now under construction at this location. Work is already under way, and plant is scheduled for completion early in 1963.

San Francisco, Calif. — Pacific Gas & Electric Co, 245 Market St, has authorized plans for a major expansion of its Morro Bay Power Station with installation of additional generating capacity for increased output. Work will begin at once on the installation of two 330,000-kw generating units at this location in San Luis Obispo County. First installation is scheduled for completion early in 1963 and the second about a year later. Cost is reported to be $80,000,000.

Atlanta, Ga. — Georgia Power Co, Electric and Gas Bldg, 52 Fairlie St, N.W., a subsidiary of the Southern Company, has announced that it will spend a record $59,500,000 this year for construction and improvements to its system. This represents an increase of $5,000,000 over the company's 1960 construction outlay of $54,500,000. Work will include installation of initial generating capacity, at a cost of $18,400,000, for increased output as well as installation of new and improved transmission and distribution lines. Work has begun and is scheduled for completion in the spring of 1963.

New Albany, Ind. — Public Service Company of Indiana, Inc, 1000 Main St, Plainfield, Ind., has authorized plans for a program involving the expenditure of $23,773,000 for expansion and improvement of its generating and transmission facilities during 1961. This compares with the $30,784,945 invested in company properties during 1960, of which $11,400,000 went into the third and fourth generating

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Any way you look at it, Powell Valve performance really pays off—performance that's conclusively proven in power plants everywhere.

You can find at Powell any type of valve you may need to handle water, oil, gas, air, steam, corrosive fluids, even molten metals and other radioactive materials used in atomic power plants.

Consequently, Powell can help simplify flow control projects and contribute real savings in time and money. For example, in describing a modern 125,000-KW steam-electric generating plant, a leading authority recently listed some 80 areas requiring a total of over 1300 valves . . . Powell could have supplied almost every one.

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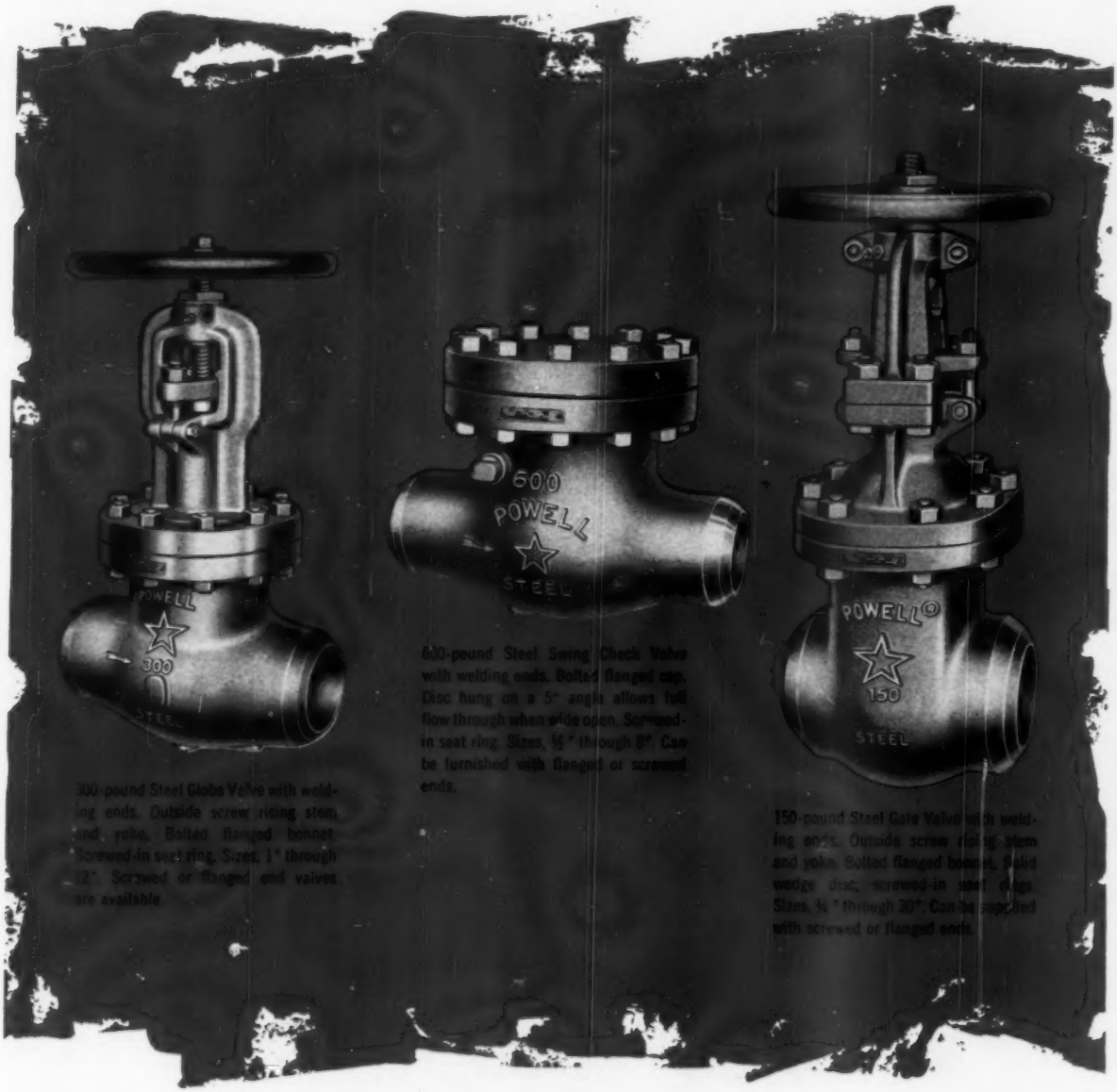

300-pound Steel Globe Valve with welding ends. Outside screw rising stem and yoke. Bolted flanged bonnet. Screwed-in seat ring. Sizes, 1" through 12". Screwed or flanged end valves are available.

600-pound Steel Swing Check Valve with welding ends. Bolted flanged cap. Disc hung on a 5° angle allows full flow through when wide open. Screwed-in seat ring. Sizes, ½" through 8". Can be furnished with flanged or screwed ends.

150-pound Steel Gate Valve with welding ends. Outside screw rising stem and yoke. Bolted flanged bonnet. Solid wedge disc, screwed-in seat rings. Sizes, ¼" through 30". Can be supplied with screwed or flanged ends.

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A new finish for Blaw-Knox Grating for better wear—and corrosion-resistance

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However, "Ponbake," the new epon base, high polymer synthetic paint process, developed by Blaw-Knox especially for grating, stays factory-new almost regardless of the treatment it gets.

This is the most rugged, durable finish available on gratings today. It has greater resistance to wear, abrasion, corrosion, chemicals and weathering than any other. Costs less than on-the-job painting. Write if you would like more information, or ask for a Blaw-Knox Grating salesman to show you a sample.

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installations at the company plant located here. Company will spend about $3,000,000 to complete the fourth 150,000-kw steam electric generating unit scheduled to go on line by the fourth quarter of 1961 or early in 1962.

Cedar Falls, Iowa — City Municipal Commission, City Hall, 612 E. 12th St, Cedar Falls, Iowa, has authorized plans for the expansion and improvement of the municipal power plant in this city. Work will include expansion and improvement of distribution and service lines in the company's trading area as well as installation of a steam electric generator with an initial capacity of 16,500 kw. Work on the project is reported to cost about $4,000,000 and will get under way at once for completion in the fourth quarter of 1962. Pfeifer & Shultz, Minneapolis, Minn., is consulting engineer of the project.

Topeka, Kansas — Kansas Power & Light Co, 800 Kansas Ave, has authorized plans for a major addition and improvement program to its Tecumseh Power Plant, located here. Plans include installation of a steam electric generating unit with an initial capacity of 175,000 kw, high-pressure boilers, and auxiliary equipment. Company has awarded a contract of $19,000,000 to the Fluor Corp, Ltd, 2500 S. Atlantic Blvd, Los Angeles, Calif., for the work. Construction of the new addition is under way and is scheduled for completion by the fall of 1962.

Paradise, Ky. — Tennessee Valley Authority, New Sprankles Bldg, Knoxville, Tenn., has announced that steel erection has begun at its proposed new plant here which will have a projected capacity of 1,300,000 kw. Plant will require 200,000 tons of steel, and the powerhouse structure will be the equivalent of a building 20 stories high. Plans call for installation of two 650,000-kw steam-electric generators, the largest installation of its kind in the world to date, at this location. Plant is being built at an estimated cost of $180,000,000. The first installation of 650,000 kw is scheduled to go on line late in 1962. General Electric Co will supply the generators, Babcock & Wilcox Co the boilers and auxiliary equipment, and Ingalls Iron Works the structural steel for the units.

Boston, Mass. — New England Electric System has announced that it has simplified its corporate structure by merging seven of its Massachusetts electric subsidiaries into one company, to be known as the Massachusetts Electric Company. The new move will provide economies in administration and production costs, provide more efficient use of line crews and a better financing vehicle. Combined assets of the new subsidiary will be more than $114,000,000, and it will serve 310,000 customers in 110 Massachusetts cities and towns. New company replaces Attleboro Electric Co, Northampton Electric Co, Northern Berkshire Electric, Quincy Electric, Southern Berkshire Power & Electric, Weymouth Light & Power, and Worcester County Electric companies.

Silver Spring, Md. — Holy Cross Hospital, Sisters of the Holy Cross, Eastern Avenue and Bunker Hill Rd., N.E., Washington, D.C., has authorized plans to construct an eight-story hospital structure on a large site located here. Plans call for a hospital of reinforced concrete and steel frame. A large two-story boiler plant and auxiliary equipment is planned. Work will begin at once under supervision of John A. Volpe Construction Co, Washington, D.C.,

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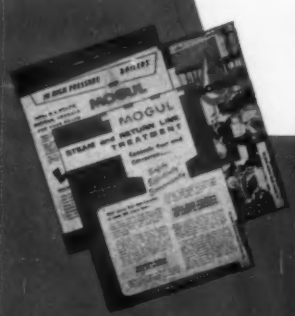

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and when completed will represent an investment in excess of $8,000,000.

Minneapolis, Minn. — Northern States Power Co, 15 South Fifteenth St, this city, has authorized plans to spend approximately $6,900,000 for expansion and improvement of its electrical transmission and distribution system. Work will include extensions and improvements in electrical distribution system in Minneapolis, construction of a new 20,000-kva substation here, and four 13,800-volt feeders, northeast of the city. Work will also include additions and improvements in company's generating capacity for increased output. Improvements in the electrical distribution system and additions are planned to the company's system throughout the St. Paul, Minn., area as well, at a cost of approximately $1,850,000. Work on the project is already under way and will be completed by the summer of 1962.

Gallup, New Mexico — Public Service Co of New Mexico, 424 Central Ave, S.E., Albuquerque, N.M., has announced contract award of $2,000,000, to the Reynolds Electrical & Engineering Co, 805 Early St, Santa Fe, N.M., for the installation of a 70-mile, 230,000-volt power transmission line between Albuquerque and Ambrosia Lake, near this place. Work on the new installation will start at once for completion scheduled by mid-1962. Additional lines were made necessary due to the ever increasing demand for industrial and residential power and light in this growing area.

Blairstown, N.J. — New Jersey Power & Light Co, 9 W. Blackwell St, Dover, N.J., has announced plans to construct a new hydroelectric power system, one of the world's largest, on a large tract of land recently acquired at this location. Preliminary construction work on the new facility will get under way this summer on the first phase of the project, which will have an initial installed capacity of 300,000 kw. It will be a pumped-storage reservoir system off Route 94 and is scheduled for completion by the middle of 1964. New plant will be built on Yards Creek at a cost of $35,000,000. A 290-acre reservoir will be created by damming Yards Creek, and an additional 165-acre reservoir will be built atop Kittatinny Mountain.

Niagara Falls, N.Y. — Power Authority of the State of New York, Coliseum Building, Columbus Circle, New York, N.Y., has announced that the initial 150,000-kw hydroelectric installation at the Niagara Falls Power Project was placed on line, the Western World's biggest power project to date, with 2,040,000 kw still to come. Started three years ago, and to be completed in the summer of 1963 at a cost estimated in excess of $720,000,000, the new unit and twelve others like it will add up to 1,950,000 kw of capacity while another twelve reversible pump-generators at the pumped-storage plant will add another 240,000 kw. Total installed capacity of the 25 units when completed will be 21,190,000 kw, with a firm capacity of 1,800,000 kw.

Courtney, Pa. — West Penn Power Co, Cabin Hill, Greensboro, Pa., has announced contract award to the Westinghouse Electric Corp for the manufacture and installation of a 250,000-kw turbine generator at company's Mitchell Station, located here. Plans include installation of the 250,000-kw turbine-generator unit, which will get under way later this year. Addition to power plant will cost an estimated $43,000,000, before completion,

Solve peak-load and standby problems! F-M's exclusive O-P Diesel Generating Units provide *full* power in 15 short seconds . . . *from a cold start!* They need no spinning reserve. Use no power till you use them! The reason? Our exclusive O-P (Opposed-Piston) design. Two pistons in one cylinder function from a *single* combustion. This minimizes *vibration* . . . produces fine *balance*, *smooth* power to peak the generator—in just 15 seconds! F-M Opposed-Piston Diesel Generating Units are available with automatic or manual controls. Produce up to 2500 kw per unit. They may be linked in multiple units for peaking, standby duty . . . or dead load pickup! You can't buy better—or more economically.

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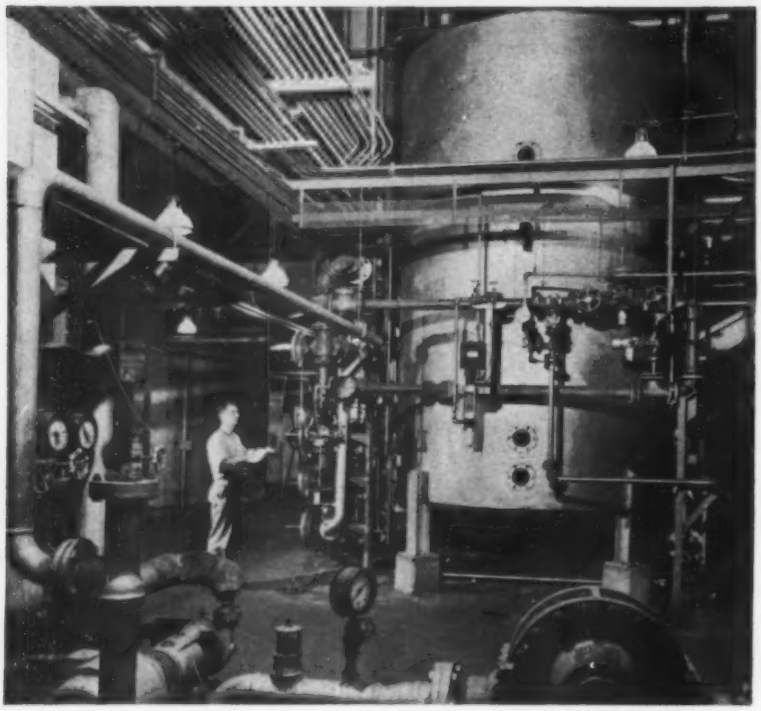

Photo courtesy Ontario Hydro

Thirst-quencher for Ontario Hydro's largest thermal generating plant

Here almost dwarfed by its surroundings in the new R. L. Hearn Generating Station, Toronto, Ontario, this Permutit® automatic mixed-bed demineralizer helps quench the thirst of generator units 1 to 8.

This demineralizer can deliver 240,000 imperial gallons of boiler feedwater a day at a nominal flow rate of 300 gallons per minute. Total solids content of the water it produces is 4 grains per gallon. The unit can deliver water with an average specific conductivity of approximately 0.3 microohms per centimeter, and a soluble silica content of 0.02 ppm.

That is pure boiler feedwater.

And it saves money, too. Because this Permutit demineralizer produces its high quality water at a lower cost than possible with evaporators. Still further economies are assured by its labor-saving, push-button automatic controls.

Deaerators, too. Further feedwater treatment at Hearn Station is accomplished on units 6, 7 and 8 with three of the most advanced design open direct-contact Permutit deaerators, each guaranteed to deliver 1,450,000 lb. per hour of deaerated water. Each deaerator is designed for 100 psig pressure and provides storage capacity for 28,000 gallons of deaerated water.

The Permutit Company of Canada, Ltd. supplied the demineralizing equipment for this important job. Stone & Webster Canada, Limited were the consulting engineers. Similarly, we can work with you or your consultant to help solve boiler feedwater and other water treatment problems. Our technical staff is at your disposal.

For more information, write our Permutit Division, Dept. PE-41, 50 West 44th Street, New York 36, N. Y.

In Canada, The Permutit Company of Canada, Ltd., 207 Queen's Quay West, Toronto 1, Ontario.

*FLUIDICS is the Pfaudler Permutit program that integrates knowledge, equipment and experience in solving problems involving fluids.

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which is scheduled for the spring of 1963. West Penn Power Co is headquartered at Pittsburgh, Pa., and furnishes power and electricity to communities in the Pittsburgh area.

McMinnville, Tenn. — Caney Fork Electric Coöperative, Inc, West Main St, this city, has announced plans for a major expansion and improvement program on its transmission and distribution facilities. Company plans to install, with the use of its own forces, new distribution lines, tie lines, and conversion of lines throughout its service area in Tennessee. Contract of $1,185,000 has been let to the W. M. Wilson Co, 719 B Seventeenth Ave, S., Nashville, Tenn., for the work which will begin this spring. Installation of lines will be completed in about 14 months.

Middleton, Wis. — American Scientific Laboratories, Inc, 4001 Sherman Ave, Madison, Wis., manufacturers of biological products, has announced plans to construct a large new manufacturing plant and administrative offices on a large site here. Plant will be a one-story structure of brick, steel and concrete, 160 ft wide and 300 ft long, with a manufacturing and office area of approximately 48,000 sq ft. Plans include the installation of a large boiler house at the proposed plant. Work on the new plant is already under way and is scheduled for completion by the fourth quarter of 1961. Cost of the new facility is reported to be under $1,000,000.

New Engineering Books

Centrifugal Pumps: Selection, Operation, and Maintenance, by Igor Karassik and Roy Carter; 488 pages, 7 by 10¼ in., cloth bound. Published by F. W. Dodge Corp, New York. Price $15.75.

Practicality has been the key word in preparing this comprehensive reference book for users and designers of all types of centrifugal pumps throughout industry. Theory is only introduced where it is essential to the understanding of specific problems.

Material on all phases of planning, selecting, operating, maintaining and trouble-shooting pump systems is presented in five main sections:

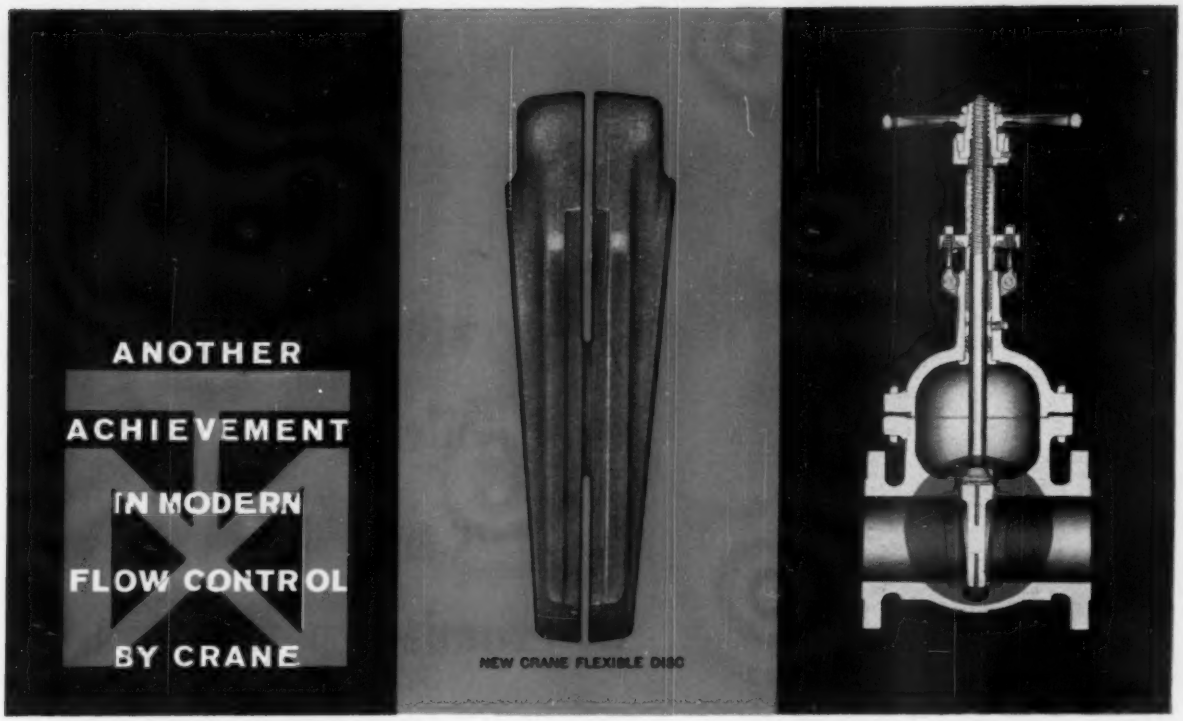
I. Pump Types and Construction
II. Pump Performance
III. Controls, Drivers, and Priming
IV. Services and Selection of Pumps
V. Installation, Operation, and Maintenance

A total of twenty-seven chapters comprise these main sections.

Special chapters are devoted to vertical pumps, self-priming units, and the so-called regenerative pumps. A detailed presentation is given on the concept of "heads," conditions of service, and performance characteristics of various types of centrifugal pumps.

Finally, a Data Section and Index add to the usefulness of the book.

This book should be of everyday use to anyone concerned with the moving of liquids or gases in bulk.



Biggest gate valve advance in 25 years

CRANE FLEX GATES

Instead of being made with a solid disc, new, patented Crane Flex Gates have separate disc faces, connected by the axle-like unit shown in the cross section. This joins the two seating faces, yet provides flexibility for the faces to seat tightly with independent action.

BECAUSE THEY'RE FLEXIBLE, new Crane Flex Gates seat with less torque.

BECAUSE THEY'RE FLEXIBLE, new Crane Flex Gates unseat with less torque...will not stick closed even when closed while hot and allowed to cool.

BECAUSE THEY'RE FLEXIBLE, minor deflection of seating faces due to pipe strains does not affect tightness of Crane Flex Gates.

BECAUSE THEY'RE FLEXIBLE, new Crane Flex Gates are tight on inlet seat and outlet seat over a wide range of pressures.

BECAUSE THEY'RE FLEXIBLE, new Crane Flex Gates can be used singly in some services where two conventional gate valves are frequently specified. You can save substantially on piping costs.

BECAUSE THEY'RE FLEXIBLE, new Crane Flex Gates can be serviced—body seat rings replaced or seating faces refinished—quickly, and without painstaking accuracy. Slightly off-taper seats do not affect tightness or operating ease.

BECAUSE THEY'RE FLEXIBLE, new Crane Flex Gates will easily outperform any conventional solid wedge disc valve you now use. *And there's no increase in price.*

BECAUSE THEY'RE MADE BY CRANE, these new Flex Gates are completely dependable. You can use them with complete confidence on steam, water, gas, oil or oil vapor service. Stem and disc seating faces are Crane Exelloy. Shoulder-type body seat rings are Exelloy or Crane No. 49 Nickel Alloy. Sizes: 12 inch and smaller; 150- and 300-pound pressure classes.

Ask your Crane Distributor for full information on Flex Gates—and for data whenever you work with the products Crane makes. He has the newest in information and products. Crane Co., Industrial Products Group, 4100 South Kedzie Avenue, Chicago 32, Illinois.

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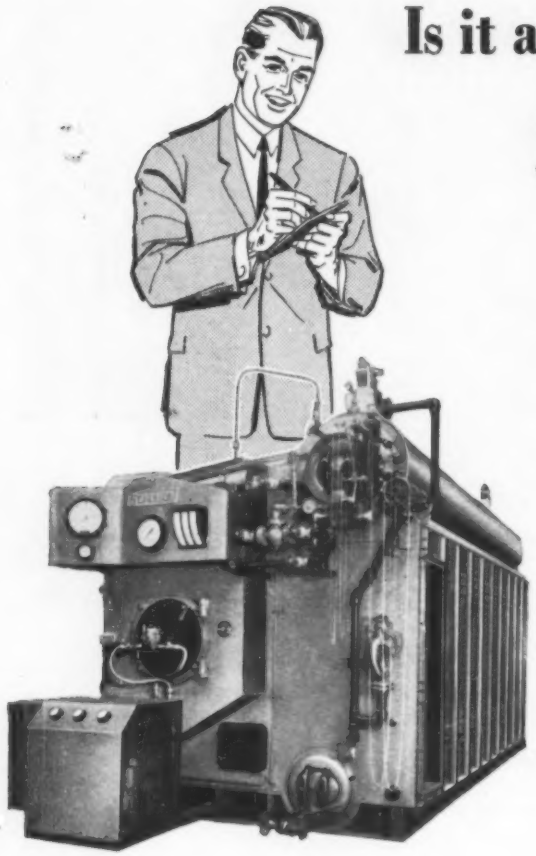

Is it an integrated package . . . or just a boiler with a burner? . . . or who stands behind its promised performance?

Ask specifically if the combustion safety controls and combustion control systems are engineered as part of the "packaged" boiler. Question the capacity of the forced draft fan . . . will the wind box provide air cooling for at least 80% of the boiler firing wall? Have all the critical components been engineered and assembled as part of the packaged boiler by the boiler manufacturer, or have they been sub-contracted, eliminating unit responsibility?

Every Superior Packaged Boiler is a completely integrated and engineered unit, backed by the undivided responsibility of its maker.

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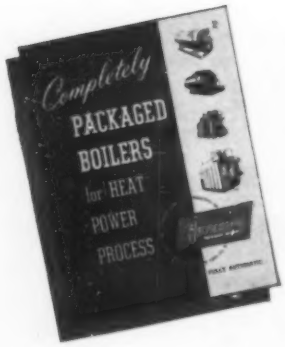

Superior Packaged Boilers of the water-tube type are designed for capacities from 4,000 to 61,000 lbs./hr., and are fired by gas, oil or both. The catalog illustrated provides condensed data on the world's most complete line of packaged boilers. Request catalog S-12

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Current Catalogs

continued from page 38

154 Cable Suspension System — Illustrated and described in Bulletin 161 by Perfect-Line Mfg. Corp. is a cable suspension system for industrial, processing, mining and other applications. Charts on how to determine requirements as well as installation suggestions are given.

Equipment Installation

155 Good Grouting Methods — Text and photos in 8-pp Bulletin EPMG-2a, of Master Builders Co., explain proper methods for grouting different types of heavy industrial equipment. Non-shrink Embeco pre-mixed grout is used to explain methods and techniques. Preparatory steps, forming, selecting materials, mixing and placing the grout are shown in diagrams, charts and photos.

156 Vibration Mounts — Described in this 8-pp bulletin, issued by Hamilton Kent Mfg. Co., is a line of vibration mounts employing "rubber-in-shear" principle to isolate vibration and suppress noise. Includes load-deflection curve, engineering details and installation data.

Other Equipment

157 Thermal Insulation — Comprehensive data on thermal insulations for all types of requirements, in applications ranging from −400 to 3000 F, are described by Johns-Manville Corp. in revised 64-pp Catalog IN-244A. Includes detailed specifications on insulations for industrial and high temperatures, plumbing, heating and air conditioning, refrigeration, insulating firebrick and refractories, and such products as asbestos papers, millboard, felts.

When using the Reader Service Cards, please be sure to give your company name and job title, even if you want catalogs sent to your home. Manufacturers prefer to send literature to those who identify themselves.

158 Powdered Acid Cleaner — Bulletin HSP-940 describes a powdered acid cleaner, made by Hagan Chemicals & Controls, Inc., for use in cleaning scale deposits from boilers, heat exchangers, water lines, pumps and other equipment. Advantages are listed and possible methods of application outlined.

159 Floodlight Selection — How to select and apply floodlights is told by General Electric Co. in 16-pp Bulletin GEA-6175C. Describes floodlight classification, general principles of floodlighting, tells how to calculate light levels for vertical and horizontal surfaces, and includes recommended footcandle levels for various applications and photometric data.

160 Heat Exchangers — Illustrated and described in Bulletin 301.7K1, of American Standard Industrial Div., are heat exchangers featuring standard pre-

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BARRINGTON, ILL.

engineered components combined into custom-built assemblies to meet specific industrial and chemical processing requirements. Specifications included.

161 Oil Filter Presses — Bulletin GEA-7141 discusses features, operation, application and filtering process of General Electric Co.'s oil filter presses and Pyranol purifiers for reconditioning insulating liquids in transformers, regulators and circuit breakers. Includes ratings and data tables.

162 Bucket Elevator Components — Basic selection data on such bucket elevator components as buckets, sprockets, bearings and take-ups is presented in Chain Belt Co.'s Bulletin 6057P, 24 pp. Simplified selection charts and informational aids allow quick selection of centrifugal and continuous discharge components.

163 Synchronous Generators — Publication 2100-PRD-250 describes a line of a-c generators in ratings from 3.75 through 62.5 kva manufactured by Electric Machinery Mfg. Co. Features of the "non-packaged" units which require no voltage regulators are covered.

164 Basic Brick Products — Descriptive information on basic brick products for use in open hearth furnaces, as well as in glass tanks, non-ferrous metal furnaces, electric furnaces, soaking pits, forge furnaces, and checkers is presented in Bulletins 32, 33, 34 and 35 by H. K. Porter Co., Inc. Advantages and physical properties are detailed.

165 Disposable Wipers — Applications of Kimberly-Clark Corp.'s disposable wipers for general purpose wiping, cleaning and polishing in industry are illustrated and described in this 12-pp product bulletin. Economy of wipers is stressed.

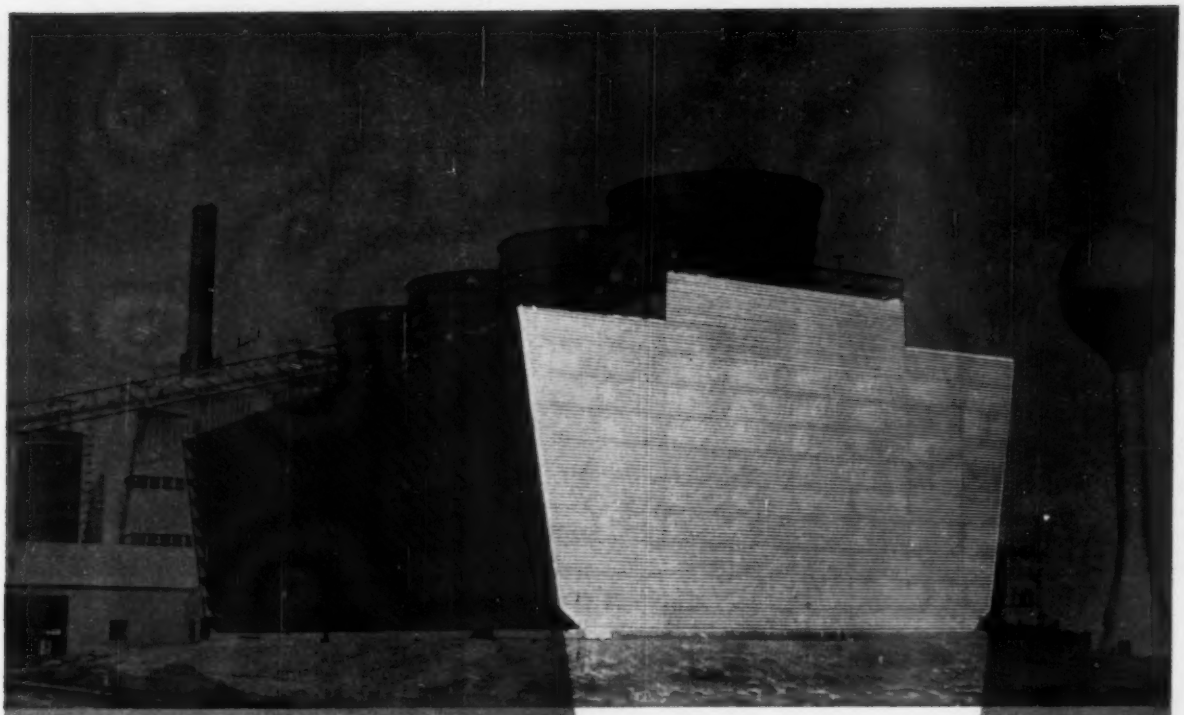
166 Improved Defrost Systems — Form 5026 issued by Dunham-Bush, Inc. describes Heat Cycle defrost systems incorporating a completely automatic, time initiated-temperature defrosting. Schematic diagrams and specifications included.

167 Elevator Maintenance — How proper care safeguards elevator service and prevents costly repairs is the subject covered in this 24-pp bulletin of Otis Elevator Co. A preventive maintenance program organized to protect elevators at economical cost is described.

168 Concrete Admixtures — This 32-pp bulletin is issued by The Master Builders Co. as a guide to concrete admixtures, iron-armoured floor products, grouting and waterproofing materials and other related products for improving concrete and mortar. Contains comprehensive specifications for concrete floors, equipment grouting and masonry mortar.

169 Two-Way Radio Explained — Sixteen-pp Bulletin ECR-568A, titled, "Under the Influence of Radio," is a pocket-size non-technical guide to two-way radio. Prepared by General Electric Co., it informs potential mobile communications users of some of the more important FCC licensing requirements. Discusses operational methods, such as how a message is sent, how to adjust a mobile radio, and record keeping.

170 Catalytic Gas Purification — Bulletin G-61 describes Catalytic Combustion Corp.'s all-metal gas purification catalysts and reactors. Describes uses of all-metal gas purification catalysts to produce industrially pure gases.



Contour of Quality!

In a Marley Class 600 Double-Flow tower, predetermined performance is as characteristic as its functionally angled profile. At Earl F. Wisdom Station of Corn Belt Power Cooperative, testing proved again why the Class 600 contour is now accepted as the symbol of ability to meet or exceed specified cooling capability. This new 30,000-g.p.m. tower selected by Stanley Engineering Company has joined the long list of *successfully tested* Class 600's, a record that is published annually.

The Class 600 contour also signifies other important design advantages: One of the most outstanding of these is the excellent balance of air volume and air velocity that permits largest capacity per fan cell. The end result is low required horsepower; less mechanical equipment; reduced maintenance cost. Further, the distinctive shape points up a high standard of durability established by liberal use of non-corrosive materials at critical points throughout Class 600 structure.

In a Class 600, quality and stamina are *evident* at a glance, *obvious* on careful examination. Evaluation amplifies the sum of these features as a value unequalled both for long term investment and for profitable plant operations.

THE MARLEY COMPANY ● KANSAS CITY MISSOURI

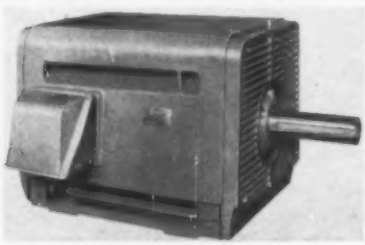
For more data circle 540 on Post Card

Equipment News

Described on these pages are new and improved products. Use 89–90 to ask for more information on them. Just circle the item numbers of all the products in which you are interested.

1—A-c motor stows big horsepower in a small, square package

In the Duty Master D-5000, Reliance Electric and Engineering Co. has put a round peg in a square hole to reduce the overall size of large a-c motors. This one has a round stator inside its nearly square frame, an arrangement said to



provide better cooling and permit smaller overall dimensions for any given horsepower rating. Available from 125 through 300 hp, the motor has large air intakes which cover each end. Air is drawn in these louvered openings, ducted through rotor and stator, and then exhausted at the sides. Class B insulation is standard and frames and removable end louvers are cast iron. The motor can be had with sleeve or ball bearings. Drip-proof enclosure is standard, but splash-proof enclosure can be specified. Also, encapsulated stators are available. Either 220, 440 or 550 line voltages may be had for 3600, 1800, 1200, 900 rpm.

2—Ladder-type cable tray supports long cable runs

Ladderway is designed by H. K. Porter Co., Inc., to support long stretches of heavy insulated power cables with straight runs and various turns. Described as economical, requiring no maintenance, Ladderway is available in galvanized steel with standard straight sections of 10 ft and a depth of 3 in. Rectangular rungs have rounded edges to prevent damage to cable insulation and rung spacings range from 4, 8 and 12 in. Sections are joined together by single-bolt connection. According to company, tests have shown tray to be safe should workmen move about on it.

3—Molded case breaker, 800-amp capacity, mounts in less space

This 800-amp molded case circuit breaker provides one-third saving in panel space according to manufacturer, I-T-E Circuit Breaker Co. Designated KM frame, this breaker (shown at left) is smaller than its LM predecessor by one frame size, but provides the same electrical features and ratings. It comes

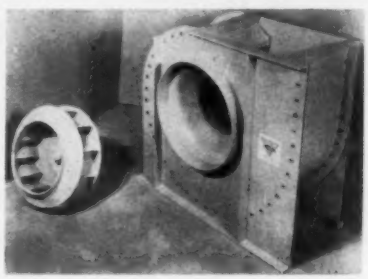
in two- and three-pole construction in current ratings of 125 through 800 amp. for 600 v a-c and 250 v d-c. Its height is 15½ in. — 6½ in. less than that of the LM unit. Depth is reduced from 5¾ in. to 4⅛ in. and width remains the same. The smaller size lets more units be mounted in a standard switchboard, while distribution and power panelboards can be built shallower because of reduced depth.

4—Distribution transformers are completely encapsulated

Produced by Line Material Industries, McGraw Edison Co., these transformers have undergone a development and testing program and will be offered to selected utilities for further evaluation under operating conditions. Present units are 15 kva, 2.4 through 7.62 kv. It is pointed out that encapsulated transformers benefit utilities by eliminating the tank which can corrode, oil which can deteriorate, and gaskets which can absorb moisture. Thus, they require minimum maintenance; and they use less pole space per mounting because they are light in weight and small in space. In their construction, company's Round Wound core and coil assembly is encapsulated in an epoxy compound said to have excellent weathering characteristics, high dielectric strength and good heat dissipating qualities. Thermal properties are comparable to present standards for oil-immersed transformers.

5—Blower housings and fans offer chemical resistance

Duracor reinforced plastic centrifugal blower housings with duracor-covered standard fan wheels are said to offer extreme chemical resistance plus high strength/weight ratios. The units can



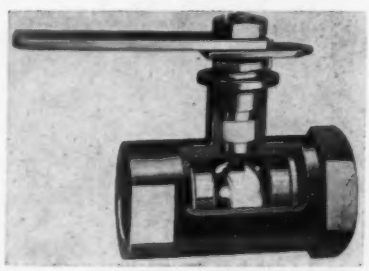
be installed as separate components in existing systems or designed into entire Duracor exhaust systems. The unit shown is part of a system designed by The Ceilcote Co. for a chemical plant; it handles free chlorine fumes at temperatures to 250 F at 12,000 cfm. Bulletin 10-C gives full information.

6—Asbestos fiber insulation to spray on electric turbines

Availability of Sprayed Limpet Asbestos for thermal insulation of steam and gas turbines is announced by Keasbey & Mattison. Material is sprayed to a thickness of several inches, directly onto the surface of the castings that form the turbine's housing. No surface treatment is required. Company points out that blue asbestos has been used in initial applications because it insulates more effectively than white asbestos at high temperature of turbine operation. Significant cost reductions are major benefits reported, as the spray-on product takes less time to apply than required for conventional insulation methods.

7—Ball valves will handle variety of fluids

Offered by the Homestead Valve Mfg. Co. in combination of metals, seats and seals to handle all types of fluids, this line of ball valves includes valves with Navy G bronze or semi-steel cast bodies; or brass, steel, and 303 or 316 stainless steel bar stock bodies. Both cast and bar stock types have full-round pipe-sized passage for fluids, or restricted passage as desired. With flexible self-forming Teflon seats and seals (other



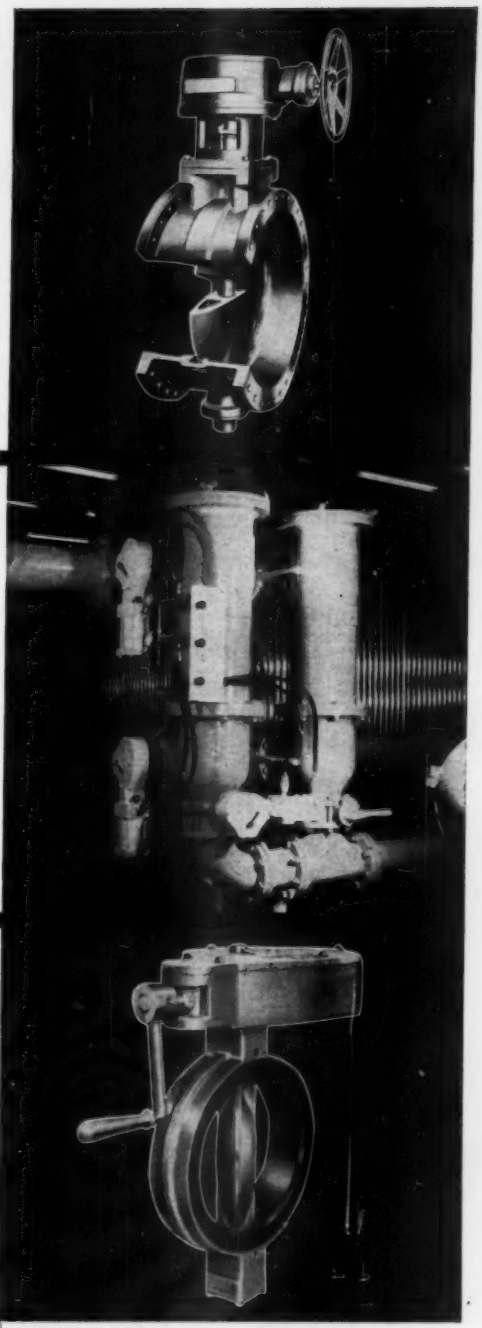
PRATT POWER PLANT PRODUCTS are all NEW for the '60's

NEW Rubber Seat Butterfly Valves

The time-proven Henry Pratt features are now augmented by such new design features as: ADJUSTABLE SEAT that can be tightened, or even replaced without removing shaft or disc. LOWER SEATING TORQUES, lowers actuator cost and provides remarkable ease of operation. Longer operating life through accurate control of disc-seat interference, giving tightness, without wear.

The new Pratt Butterfly Valves are available in sizes 3" through 144" and for pressures to 150# in both wide and narrow face-to-face. Also furnished with integral expansion joint.

Write for complete information.



NEW PRATT CYCLONE STRAINER

The new Pratt Cyclone Strainer eliminates the manual cleaning usually associated with this type of equipment. Backwashing operations are completely automatic and can be accomplished in seconds.

Unique design simplifies piping and installs for *far* less than ordinary designs.

Patented "Cyclone" action keeps larger particles away from basket—keeps strainer "on the line" longer.

Features rubber seat butterfly valves for longer life and positive action. Manual or automatic valve operators.

Write for Bulletin S-1-G.

NEW Monoflange Mark -II

No valve is easier to install or operate. The Monoflange fits between existing pipe flanges—no gasket is necessary. With completely tight shut-off at 150# psi, the Monoflange Mark II finds many applications where economy is paramount, but long life is necessary.

New "Sidewinder" manual operators are available for standard or buried service with crank, handwheel or chainwheel. Cylinder, Diaphragm topworks or electric motor operators also available.

Write for Bulletin B-10-G.

HENRY PRATT®

Creative Engineering for Fluid Systems

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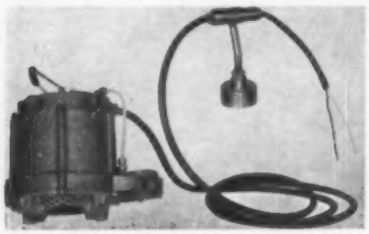
Representatives in Principal Cities

For more data circle 541 on Post Card

materials available soon), valves range from ¼ to 2½ in. for pressures to 400 lb wog, and temperatures to 450 F. Section 5, Reference Book 39 gives more data.

8—Submersible pump protects underground transformer

Model 119-A44, a heavy-duty submersible pump produced by Kenco Pump Div., has a separate breather control (shown at right) and facility to tie into a waterproof conduit box, a rugged cast-bronze housing, and an oil-filled sealed ½-hp motor of 3300 gph capacity at a 10-ft head. Its two-vane non-clog impeller is designed to handle solids as well as liquids — including popsicle

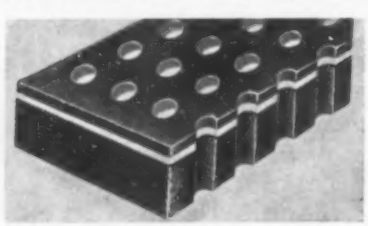


sticks, cigarettes, gum wrappers etc that fall through vault grates and must be removed with drainage and ground water. A 3½-in. opening in its strainer base assists in non-clog operation.

The diving-bell arrangement of this pump's breather control traps air in its skirts as the fluid level rises, and this pressurized air forces the nylon-Neoprene diaphragm, inside the control, to flex and close the switch contacts starting the pump. Thus, it is pointed out, water is removed before it can damage transformer. As further protection, this pump can be installed with a protected connection of the power cord into a water-tight box. Produced for 115-v and 230-v operation, it is equipped with 10- or 20-ft power cord and cap.

9—Machine undermounting reduces transmitted vibration

Perf-O-Grip Vibra-Mount, of American Felt Co., combines cushioning effect of resilient wool felt with a series of perforations spaced at intervals throughout the mounting pads which provide lateral flexibility and help eliminate horizontal "creep" vibration while providing control. This undermounting is claimed to reduce the destructive force of transmitted vibration by as much as



85 per cent. In many cases, machinery can be positioned and installed without need for lag bolts in the floor. To install, a suitable adhesive is applied to both sides of the pad. The mounting comes in general purpose and heavy duty densities. The former is for loads from 10 to 50 lb per square inch. Heavy duty density if recommended for heavier machinery load applications.

10—Drawout fused switch protects the high voltage circuits

Westinghouse Electric Corp. announces metal-enclosed switchgear, Type DFS, for moderate cost protection of 2400- to

13,800-v distribution circuits — for applications not requiring circuit breakers. It is built around a drawout design in which switch-and-fuse element is withdrawn from enclosure whenever fuses are replaced. Equipment can be had for indoor or outdoor service, as single-circuit units or multi-circuit switching centers for service entrances and transformer primary or secondary switching. It comes in 5 and 15 kv, in 600- and 1200-amp continuous.

Switches are designed to interrupt load currents equal to continuous load ratings for at least 20 times. Equipped with boric acid fuses or current limiting fuses, the equipment interrupts fault currents to 250 mva at 4160 v and 500 mva at 13,800 v. Use of boric acid fuses permits application to transformers up to 5000 kva at 13,800 v. For closing against faults and to make manual operation independent of operator, energy required to open and close the switch is charged into a spring system manually, or by optional motor-driven charging mechanism. The stored energy mechanism provides force to close switch against momentary currents of 60,000 amp for the 5-kv switch, 40,000 amp for the 15-kv switch.

11—Forged steel strainer for high pressure service

Armstrong Machine Works has announced a forged chrome moly steel strainer, designed for 2500 psi pressure at temperatures to 1050 F, and for 6000 psi at 100 F. It is available in two sizes and four pipe connections: 26 lb, ¾ or 1 in., and 56 lb, 1¼ or 1½ in. Socket weld connections are standard, including a socket weld blow-down connection. Gasket is spiral-wound stainless steel — asbestos. Standard screen is perforated Monel sheet with 233 0.045 in. diam holes per square inch.

12—Gasket compound for semi or permanent connections

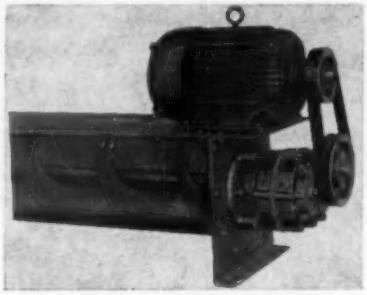
Seal-Last is offered by Crane Packing Co. for leakproofing gasketed assemblies and repairing broken gaskets, for building up damaged, misaligned or warped flanged surfaces, or as a gasket substitute where surfaces permit. The compound can be used for many industrial fluids and gas services, including water, steam, oil- or water-based hydraulic fluids, L-P and natural gases, petroleum products, mild corrosives and many chemicals. Temperature range is −65 to 400 F, pressures to 5000 psi. Seal-Last comes in a soft-set type for connections that must be periodically disassembled and a hard-set type for permanent installations. The former remains plastic. The hard-set compound dries quickly and sets hard, states company; it withstands vibration as well as contraction and expansion due to temperature change.

13—Safety solvent features controlled evaporation

Turco-Solve offers a combination of detergent action plus controlled evaporation, according to Turco Products, Inc., allowing solvent to stay wet and working just long enough to clean thoroughly in minimum time. Controlled evaporation also reputedly reduces solvent vapors in air, minimizing toxocity and flammability. Solvent is designed for in-place-spray-cleaning of motors, generators, switches, control panels, rheostats etc. It is described as non-corrosive and non-conductive.

14—Compact drive for short screw conveyor application

Designed for short conveyor flights and low horsepower requirements, the Series 100 Drive of Dodge Mfg. Corp. comes in two speed ratios: 8:1 for up to 6 hp at 225 rpm, and 18:1 for up to 3.8 hp at 100 rpm. The unit consists of a double-reduction speed reducer with packing gland and driving shaft which mounts on a trough end. The drive is designed to

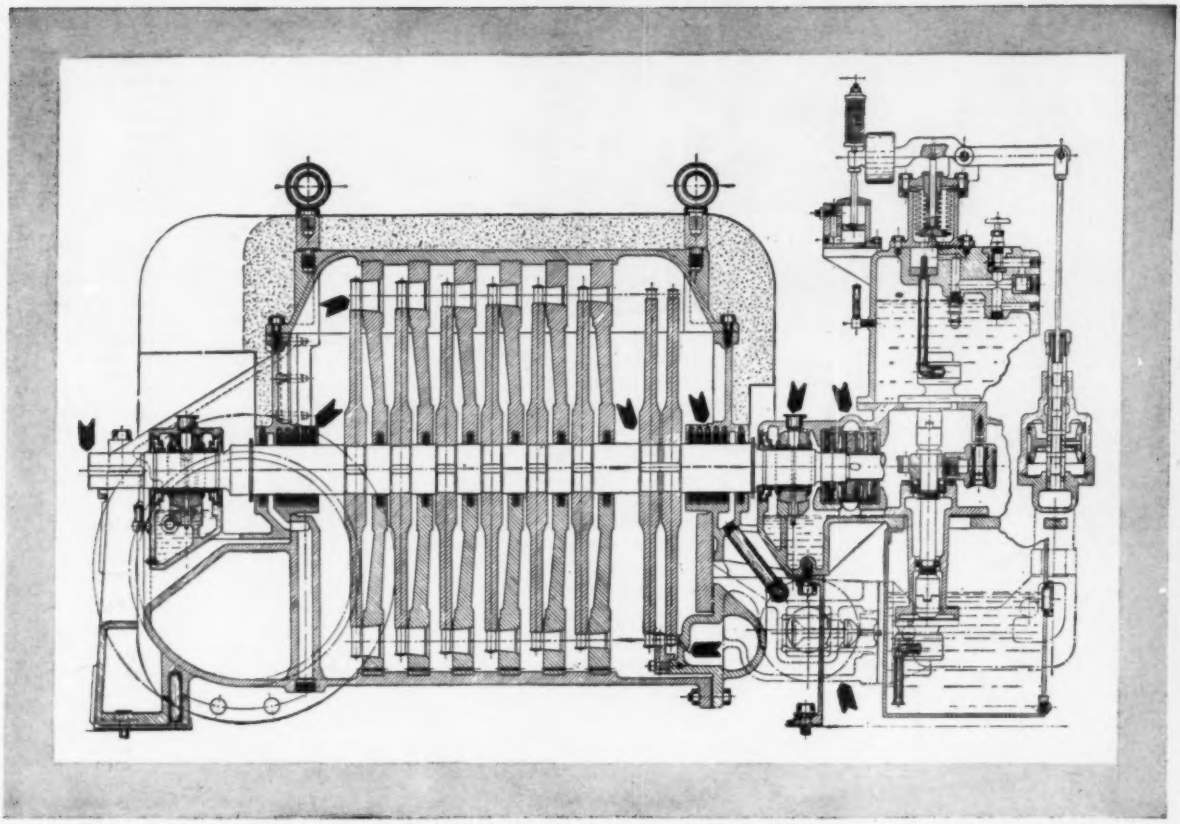


triple-seal the reducer unit against invasion by materials conveyed. The packing gland is adjustable from the outside, takes standard packing and may be inspected by sight. Slotted holes in the flange of the reducer permit the unit to be rotated for adjustment of V-belt drive center distances.

Heavy-duty tapered roller bearings in the reducer take thrust from the screw in either direction. Driving shaft is mounted in a steel sleeve, and built-in puller facilitates changing shaft without opening the reducer. Entire drive is mounted or removed from trough end with three bolts in reducer flange. Any desired output speed may be had by selecting correct V-belt drive to transmit motor power. Bulletin 601 gives data.

15—Metering pump offers unitized construction

Series 100 is announced as the smallest in the Wallace & Tiernan Inc. line of plunger metering pumps, and is designed to give accurate, economical metering against pressures to 1200 psi. Capacities range from 0.95 gph vs 1200



ANOTHER INSIDE STORY OF THE UNIVERSAL ACCEPTANCE OF MURRAY MULTI-STAGE TURBINES IN THE MECHANICAL DRIVE FIELD

- Husky accurately machined shaft.
- Discs shrunk and keyed in place.
- Stainless steel nozzles and blading throughout.
- Spherical seated sleeve bearings.
- Kingsbury thrust bearing.
- Center line support.
- Carbon ring gland seals.
- Double seated balanced governor valve — stellited.
- Choice of speed governors from simple mechanical type to precision oil relay.
- Bolt type overspeed trip governor.
- Steam conditions to 600 PSIG and 750°F.
- Condensing or non-condensing.

Our nearest representative will gladly help you solve your mechanical drive turbine requirements. Just write to Murray Iron Works Company, Burlington, Iowa, for his name.

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CUSTOM SHEET & PLATE FABRICATION

It takes modern equipment plus craftsmanship and know-how to produce fabrications such as the giant generator housing shown here—illustrative of Kirk & Blum's ability to produce the unusual as well as the conventional types of weldments. In its 170,000 sq. ft. plant, with crane capacity to 25 tons, Kirk & Blum has complete facilities to produce, preassemble and finish a wide variety of carbon steel, stainless, aluminum, monel and other alloys assemblies up to ½" thickness. Fifty years of exceptionally varied experience is your added assurance that the job will be done quickly and economically.

Send prints for prompt quotations or write for detailed literature: The Kirk & Blum Mfg. Co., 3230 Forrer St., Cincinnati 9, Ohio.

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CONTROL PANELS AND DESKS
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INSULATING JACKETING
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FABRICATION

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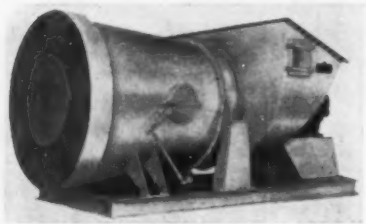
psi, to 50 gph vs 100 psi, at repeatable accuracies within 1 per cent. Available with one or two liquid ends, the second liquid end may be used to double capacity, or for proportional blending of two liquids. Stroking length of either liquid end may be adjusted individually, while pump is running or stopped. Unitized construction is said to prevent misalignment and assure long pumping life. Catalog 420.100 gives details.

16—Axial flow fan permits blade adjustment during operation

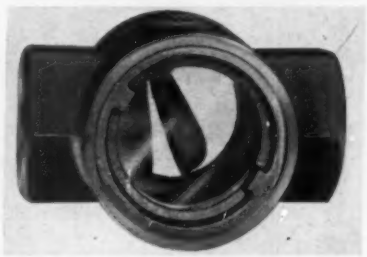
SF Axial Flow Fan is provided with impeller blades that can be adjusted during operation, according to American SF Products, Inc., allowing air flow to



be regulated while fan is kept running at constant speed. Thus variations of air or gas flow can be effected with regulation economy and efficiency over entire range. Large axial fans can be used for motor speeds of 725, 980 or 1450 rpm. Sizes are available for flows ranging from 30,000–600,000 cfm.

17—Sight flow indicator permits inside view of flow

Flo-Eye Indicator, announced by Schutte and Koerting Co., lets you look inside your pipeline to determine if there is

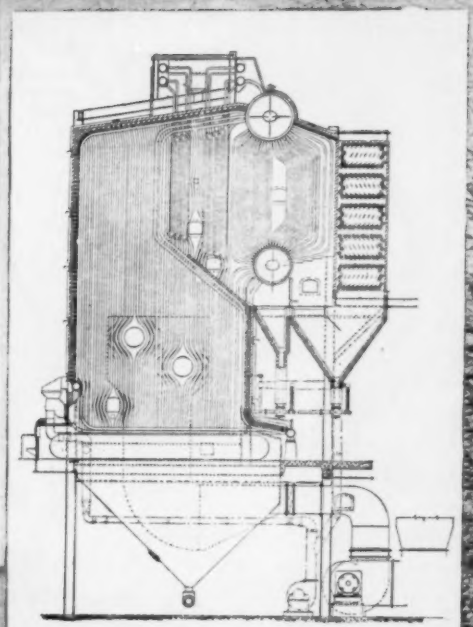


flow and the direction and condition of fluid. It features double sight glasses for clear observation of fluid, and machined recesses and retaining rings for even seating of sight glass gaskets to prevent leakage. Reasonable initial cost and simple installation are other advantages claimed.

18—Automatic emergency light protects against power failure

Fully automatic and low in cost, the Exide Lightguard Model D is claimed to operate instantaneously if normal power fails and shut itself off when power is restored. A product of Exide Industrial Marketing Div., The Electric Storage Battery Co., the unit is powered by a 9-v dry-cell battery; it costs less than comparable wet-cell equipment and requires less maintenance. Manufacturer says the Model D can be installed and left unattended for the entire service

FUEL SAVINGS 16%



Longitudinal section of Union Type VO Steam Generator at City of Ames.

JOB: Includes delivering steam for a 12,650 KW Turbo-generator in Municipal Power Plant, City of Ames, Iowa.

STEAM GENERATOR: A Union Type VO Single-Pass (140,000 lbs./hr., 630 psi, 825° F). Fired by continuous ash discharge spreader stoker. Equipped with extended surface economizer for heat recovery. Selected for its adaptability to multi-fuel firing.

RESULTS: In continuous operation for six months, supplying total steam requirements, the Union VO was credited with fuel savings of 16%.

UNION IRON WORKS · ERIE, PENNSYLVANIA
DIVISION OF RILEY STOKER CORP.

UNION

steam generators

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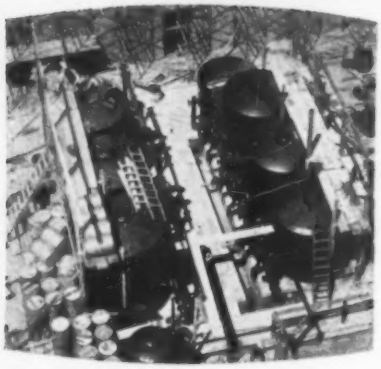
PATHWAYS OF A PIONEER

ILLCO-WAY DESIGNERS AND BUILDERS

MODERN EQUIPMENT FOR ionXchange



This picture was taken in *1943* of a Continuous *600 gpm* IonXchanger during installation at a midwestern chemical plant. The tanks are shown being loaded with ionXchange resins.

Blazing the Trail for De-I Developments

When the photograph above was made, IWT already had well over 50 large industrial ionXchangers in successful operation — yet ion-exchange in those days was still considered a "new and untried" process! Many of these pioneering IWT installations are *in use today*, and most of the early users of IWT ionXchange have *added to* and *modernized* their equipment as new developments became available.

Even today IWT is still pioneering — adding to its great stock of knowledge in this specialized field, designing and building up-to-date ionXchangers of all types and sizes for application to a wide variety of processes as well as all kinds of water-treatment, experimenting with and carefully testing new ionXchange uses, and constantly improving existing designs.

THIS EXPERIENCE CAN MEAN A LOT TO YOU

If you need pure water for high-pressure boiler make-up or process use, or if you are considering the use of ion-exchange for purification or concentration of chemical products, be sure to take advantage of IWT pioneering experience and specialized knowledge. *Call your IWT representative.*

ILLINOIS WATER TREATMENT CO.
840 CEDAR ST., ROCKFORD, ILLINOIS
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CANADIAN DIST.: Pumps & Softeners, Ltd., London, Ont.

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life of the battery, and a fresh battery can be installed in a few minutes. Model D gives up to 3¼ hr of emergency lighting with one lamp, 1½ hr of protection with two lamps. It is equipped with one 25-w PAR 36 sealed beam lamp, adjustable horizontally and vertically, that can be mounted on the case of the unit or connected remotely.

19—D-c insulation resistance tester, portable, hand cranked

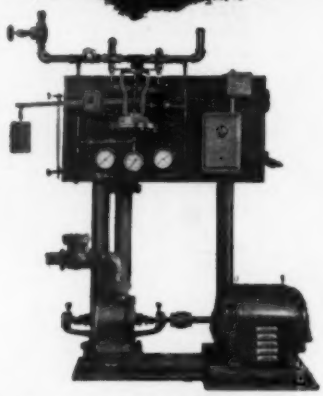
Multi-Amp Type M is a 5-lb miniature tester available from Multi-Amp Electronic Corp. for reading insulation resistance of electrical machinery, control, communication equipment, cable, wiring, and electrical parts. Testing is by

direct current which is internally converted from alternating current supplied by the manually operated generator. Testers are available for four rated voltages and five ranges of resistance (from 1000 v/2000 megohms to 100 v/20 megohms), with accuracy given as within ±5 per cent of rated resistance values, response of 0.5 sec. Tester can be carried with its fold-back type metal handle. Catalog SB-IRT-1 gives details.

20—Motor control center offers performance, safety benefits

Safety Jack Motor Control Center, of Rowan Controller Co., consists basically of an assembly of combination starters on a free-standing vertical section with up to six units per section. It features simplicity and access to components and wiring compartments, plus isolation of starter units from the horizontal and vertical bus and wireways — minimizing possibility of a fault spreading from one section of the control center to another. For greater personnel safety, the Safety Jack is permanently wired to the vertical cable bus; the bus is never exposed. The center is equipped with "take-apart"

Cut Steam Costs with Stickle's differential drainage and boiler return system



A closed pumping system for returning condensation from heating and processing equipment under pressure directly to boiler at temperatures only 15 to 20 degrees lower than those at operating pressure. For plants using steam pressures between 50 and 250 lbs. Cuts the cost of steam these eight ways:

1. Cuts fuel costs 10% to 25% by completely salvaging condensate and returning to boiler at 300 degrees or higher.
2. Raises production with higher, more uniform boiler pressure, higher temperature steam.
3. Reduces use of raw make-up water 85% to 90%.
4. Cuts maintenance on boilers, steam lines, traps and valves.
5. Improves quality by permitting operation of processing units at peak efficiency.
6. Cuts power used for pumping up to 75%, since system requires only 25 lbs.
7. Automatically maintains positive circulation without steam loss.
8. Eliminates flash steam waste.

FREE BULLETIN!
Write or wire for details and free Bulletin 250.

STICKLE STEAM SPECIALTIES CO.
2241 Valley Ave. • Indianapolis 18, Ind.
SINCE 1905

Stickle Equipment
Cuts the cost of steam

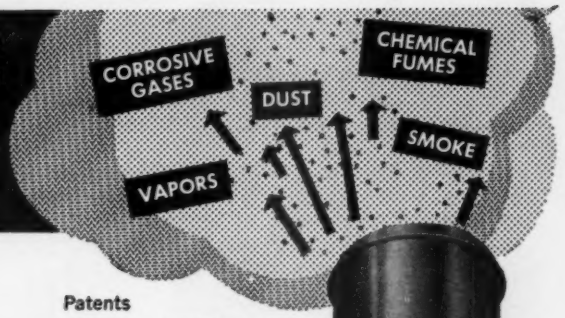
Steam Traps • Feed Water Heaters
Regulating and Reducing Valves
Drainage and Boiler Return Systems

For more data circle 546 on Post Card

HIGHER COMBUSTION EFFICIENCY! *LOWER* MAINTENANCE COSTS!

NO MOTORS, FANS OR BEARINGS IN EXHAUST LINE

PERFECT DRAFT-CONTROL BY **Quickdraft**

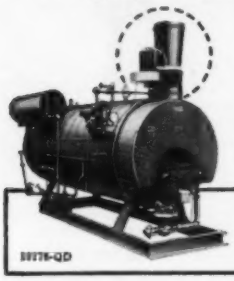


★ EXTREMELY HIGH NEGATIVE PRESSURES
★ ACID RESISTING FINISHES
★ HIGHLY EFFICIENT WITHOUT CHIMNEY

FOR INDUSTRY . . . Now you can boost the combustion efficiency of your boilers, regardless of the fuel you use. Quickdraft power-draft units provide instant controlled draft and completely remove all combustion, corrosive and noxious fumes at high temperature without passing them through the blower and motor. Maintenance costs are drastically reduced. Specify a Quickdraft unit to meet your particular requirements from a wide selection of various sizes.

FOR INSTITUTIONAL AND COMMERCIAL BUILDINGS . . . Quickdraft eliminates costly, tall and unsightly stacks. Vent incinerators, heating plants and water heaters at roof level . . . safely and efficiently.

Patents
U.S. 2,722,372 and 2,855,874
British 802,920
Canadian 593,817
Other patents pending



FOR CORROSIVE SERVICE

All Quickdraft units are available in standard acid resisting vitreous enamel, 316 stainless steel, carpenter 20 rigid plastics (P.V.C), and with plastic or Fiberglas coatings.

One of many actual installations with or without chimney.

Write for QUICKDRAFT ENGINEERING DATA on your letterhead . . . today

Quickdraft CORPORATION
P.O. Box 87-E, Canton 1, Ohio

MANUFACTURERS OF ALL TYPES OF MATERIAL HANDLING UNITS WITH EXTREMELY HIGH VELOCITIES.

For more data circle 547 on Post Card

SURPLUS PIPE AND VIBRATORS FOR SALE

12′	4″ XXH Chrome moly pipe, ASTM, A-335, P-22, 2¼% Chrome, 1% molybdenum, plain ends.
306′	6″ XXH Chrome moly pipe, ASTM, A-335, P-22, 2¼% Chrome, 1% molybdenum, plain ends.
34′	8″ sch. 160 seamless pipe, grade "B", ASTM, A-106 plain ends.
228′	8″ sch. 40 carbon, ½% moly pipe, ASTM, A-335, PL, plain ends.
36′	8″ sch. 60 chrome moly pipe, ASTM, A-335, P-22, 2¼% chrome, 1% molybdenum, plain ends.
139′	10.5″ O.D. 1.25″ minimum wall, 2¼% chrome, 1% molybdenum, alloy steel pipe, ASTM, A-335, grade P-22, plain ends.
27′	10.75 O.D. sch. 60 chrome moly pipe, ASTM, A-335, P-22, 2¼% chrome, 1% molybdenum, plain ends.
70′	12″ sch. 160 seamless pipe, grade "B", ASTM, A-106, plain ends.
53′	18″ .750 wall chrome moly pipe, ASTM, A-335, P-22, 2¼% chrome, 1% molybdenum, plain ends.
401′	18″ O.D. 1″ min. wall, 1⅛″ nominal wall thickness, 15⅝″ min. I.D. chrome, moly pipe, ASTM, A-335, P-22, 2¼% chrome, 1% molybdenum, plain ends.

Penflex M-100 stainless steel No. 15 flexible metal tubing with 150 lbs. ASA std. Tite-pak flanges attached each end in diameters and lengths as follows:

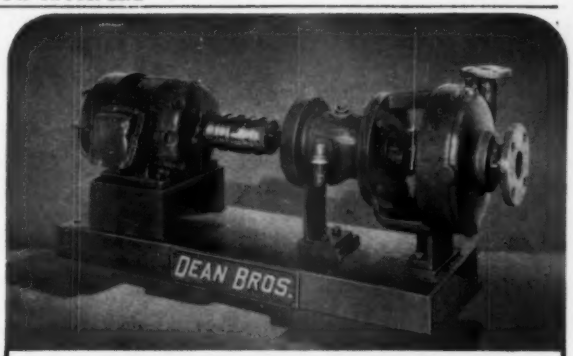
2—8′	5⅜″ x 10″ diam.
6—8′	4⅜″ x 4″ diam.
12—3′	1¼″ x 4″ diam.
5—4′	x 10″ diam.
4—2′	5⅜″ x 3″ diam.
4—3′	1⅜″ x 6″ diam.
8—3′	11⅛″ x 8″ diam.
4—2′	6⅝″ x 8″ diam.
4—3′	1¼″ x 6″ diam.
5—4′	1⅜″ x 10″ diam.

41 G.E.C. Sherwin immersion type MS2B bunker vibrators.

THE ABOVE MATERIAL IS ATTRACTIVELY PRICED FOR QUICK SALE

For further information and particulars contact the Disposal Supervisor, EELmont 1-4111, local 2-8753, Surplus Equipment and Materials Department, Ontario Hydro, P.O. Box 905, Kipling Avenue, Toronto 18, Ontario, Canada. All subject to prior sale.

ONTARIO HYDRO



For Greatest Savings in Pumps Get a Dean Brothers GS

Here is the pump that put *service* back into pumps. And with Dean Brothers exclusive service parts policy, no worry about down time waiting for obsolete replacement parts . . . there are no such things. One day delivery. Consult yellow pages for nearest representative, or wire, phone or TWX direct for fast dependable service.

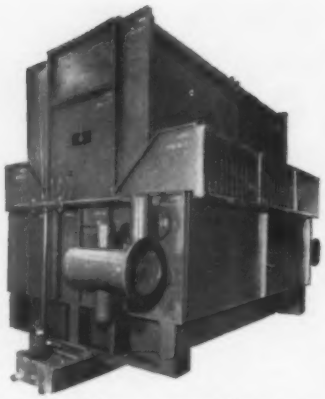
Type GS Standard Centrifugal Pumps
For general, industrial and chemical service
Capacity: to 300 gpm @ 1750 rpm—to 600 gpm @ 3500 rpm
Head: 20 to 80 ft @ 1750 rpm —80 to 300 ft @ 3500 rpm
Pumping Temperature: —150° F to plus 350° F
Working Pressure: to 180 psig @ 350° F

For Full Information Ask for Circular 190

DEAN BROTHERS PUMPS INC.
INDIANAPOLIS 7, INDIANA
The Best Is Our Standard

For more data circle 548 on Post Card

You Get EXTRA SAVINGS From This Method of Compressed Air After Cooling



Cooling water savings and power savings quickly repay the cost of the Niagara Aero (air-cooled) After Cooler for compressed air or compressed gases. In addition its long life and the labor-saving simplicity of its maintenance give you an extra profit in comparison with water-cooled surface contact methods.

With the Niagara After Cooler the heat of compression is removed and dispersed into the atmosphere by the evaporation of a very small amount of water. The compressed air temperature is always brought below that of the atmosphere surrounding your air lines, so that no further condensation can take place.

Large users of compressed air for plant services or processes choose Niagara Aero After Coolers for their dependable durability. They have been making good records of service for over 25 years.

Write for Bulletin 130.

NIAGARA BLOWER COMPANY

Dept. E-4, 405 Lexington Ave., New York 17, N. Y.

Niagara District Engineers in Principal Cities of U. S. and Canada

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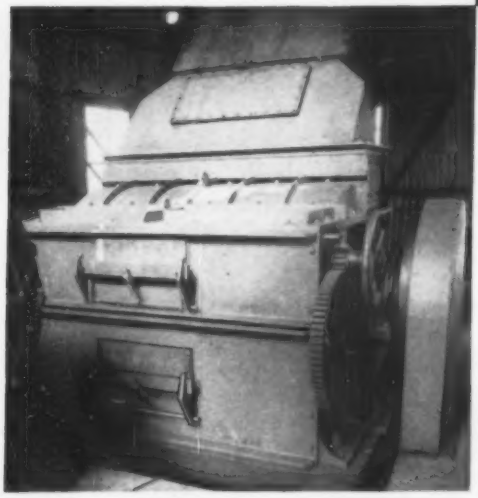
CRUSHING FACTS

from American PULVERIZER CO.

USER REPORTS



"We've reduced 2,521,000 tons of 2" N & S coal to a ¾" product. Rings and screens have been renewed only once. Replacement parts have cost $0.0016 per ton, including standby parts."

When you figure Costs, the best results come from American Rolling Ring Crushers.

American PULVERIZER COMPANY

ORIGINATORS AND MANUFACTURERS OF RING CRUSHERS AND PULVERIZERS

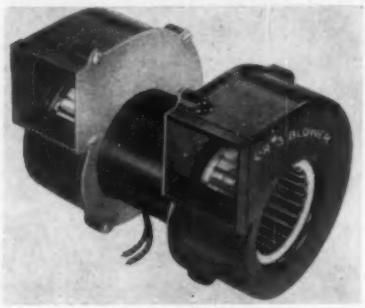
1431 MACKLIND AVE. ST. LOUIS 10, MISSOURI

For more data circle 550 on Post Card

contactor having an armature and cover assembly which can be removed without tools. Vertical sections can be grouped in straight line, back-to-back etc. combinations; can be had in various enclosures.

21—Dual-outlet blower has phenolic plastic housing

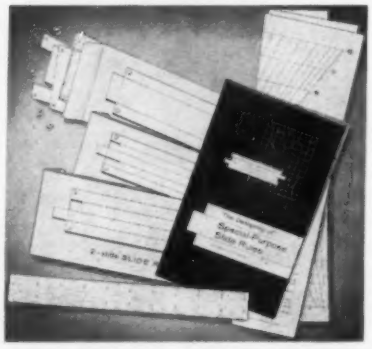
Model 8481 Dual-Outlet Blower for heat dispersion (Ripley Co., Inc.) has a one-piece, impact resistant phenolic plastic housing measuring 6⅜ in. from top to



bottom. Total width of motor and blowers assembly is 7¾ in. Motor is 115 v, 60 cycles. Unit incorporates sealed ball bearings requiring no maintenance, operates in ambient temperature −34 to 93 C. Although designed as a rack blower, it can be adapted to such applications as dispersion of heat generated by electronic equipment, induction heaters, instrument cabinets.

22—Kit lets you make slide rules to suit your own needs

Dyna-Slide Co. offers a special-purpose slide rule kit with which you can design and construct a special purpose slide rule for doing recurring calculations connected with your work. An illustrated instruction booklet shows how to assemble the blanks, explains theory of slide rule design, and gives procedures for expressing almost any problem or equation on a special purpose slide rule. In the kit are parts for making three basic slide rule blanks, a plastic scale



plotting ruler, universal logarithmic chart and instructions. The blanks have one, two or three slides, are made of drawing cardboard and plastic. Assembled rules are 3 by 11 in.

It is pointed out that little skill is required to use a special purpose slide rule; you need only to align various values with each other and read the answer. And since the scales are calibrated with actual values they are to

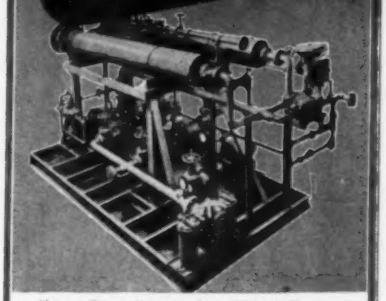
save on installation and maintenance

with

EAGAN

"pre-packaged"

FUEL OIL PUMP and HEATER SETS



Use an Eagan "pre-packaged" fuel oil pump and heater set for the preparation of heavy oil for combustion. You save time and money because units are completely assembled, ready for immediate installation. Only connections to oil and steam supply, burner, by-pass and relief lines have to be made and you avoid the combustion difficulties so often caused by field assembled combinations.

Here are additional benefits Eagan gives you:

- **Generous reserve capacity, at least 50% over peak burner demand, allows for eventual wear and future demand increases.**
- **Maintenance is easy and at a minimum. Parts requiring service are easily accessible.**
- **"Honest", solid construction, excellent engineering assure long life, trouble-free operation.**
- **Compact units save space.**

EAGAN fuel oil pump and heater sets heat to 300° F, pump to 400 psi and have capacities to 3000 gph. Single or duplex units are available for steam or electric drive. Duplex "electro-steam" sets provide for electrical failure by incorporating one steam pump and one electric motor driven pump. Other EAGAN sets can be made to your special requirements.

Write, wire or call for further information or let us bid on your job.

WALTER H. EAGAN CO., INC.

2337 Wallace Street, Phila. 30, Penna.

CEnter 6-2300

Mfrs. of condensate, boiler feed, turbine, centrifugal and proportioning pumps and fuel oil pump and heater sets.

Pump Specialists Since 1920

For more data circle 551 on Post Card

represent, you don't have to figure out decimal point placement. The kit sells for under $9.00, with additional slide rule blanks available at $2.50 each.

23—Semi-conductor rectifier for outdoor installation

This Unitron Semi-Conductor Rectifier is custom made by I-T-E Circuit Breaker Co. Designed for outdoor installation, it requires no additional housing or weather protection. It is rated 2500 amp at 225

v d-c and features unit construction in which the incoming line disconnect switch, oil-cooled transformer, voltage regulator and rectifier section are integrated into a single self-contained unit. It can be installed in less than 80 sq ft, a saving of about 20 per cent in area required for conventional units of comparable rating. This compact construction is achieved through use of a unique oil cooling system in which rectifier diodes are in the lower front portion of the transformer tank and cooled by the transformer oil.

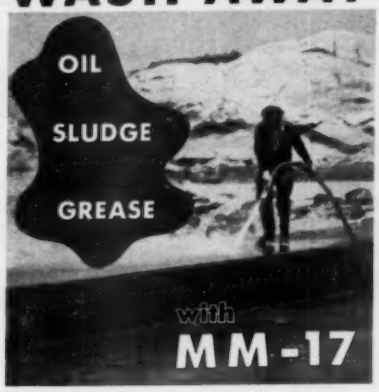
Reader Service Cards on pages 89–90 make it easy to get further product information.

24—Atomic reactor designed for economical power production

The Nuclear Systems Div. of The Marquardt Corp. announces the Direct Cycle Diphenyl Reactor (DCDR) designed to produce electrical power at costs competitive with conventional steam-electric plants in the 5000- to 20,000-kw range. Cost savings are attributed to use of reactor coolant, diphenyl, as the working fluid in the energy conversion cycle. Properties of diphenyl make it possible to expand saturated diphenyl vapor in a turbine without condensation. Thus, moisture separation and vapor reheat are eliminated. Also, the low vapor pressure and non-corrosive nature of diphenyl allow both a simpler turbine design and the use of low-alloy steel throughout.

The reactor uses graphite as a combined neutron moderator and fuel jacket, which results in high temperature capability for fuel elements and minimizes coolant decomposition. Although designed especially for small electrical systems, the DCDR is also suggested for industrial plants because of the possibility of combined electrical and process

WASH AWAY



Sea wall at Scituate, Mass., where heavy deposit of bunker oil from sunken tanker was completely removed by spraying MM-17 on oil and hosing off with water.

- **Quickly and safely emulsifies oil spills**
- **Flushes clean with fresh or salt water**
- **Non-explosive, no toxic vapors, does not burn skin**

MM-17 overcomes emergencies caused by oil spills on land or water. It is the safest and most efficient emulsifier extensively used for this purpose.

MM-17 cuts through deep layers of heavy oil and sludge where ordinary solvents fail. Here is a scientific cleaner for oil tanks, pipe lines, piers, loading platforms and oil handling equipment.

MM-17 is sprayed or brushed on the surface to be cleaned. In minutes, oil and grease can be hosed off or wiped away.

Get ready now for annual clean-up and emergencies. Order MM-17 today and have it on hand when you need it.

Single drums (55 gal.) . . . . . $2.42/gal.
Six drums on same order . . . . $2.18/gal.
Bulk shipment prices on request.

FREE Barrel Drain Truck with first order. Listing for $31.50, this truck is yours free with your first drum of MM-17.

ROCKLAND INDUSTRIES, INC.

CHEMICAL DIVISION

63 Grove Street

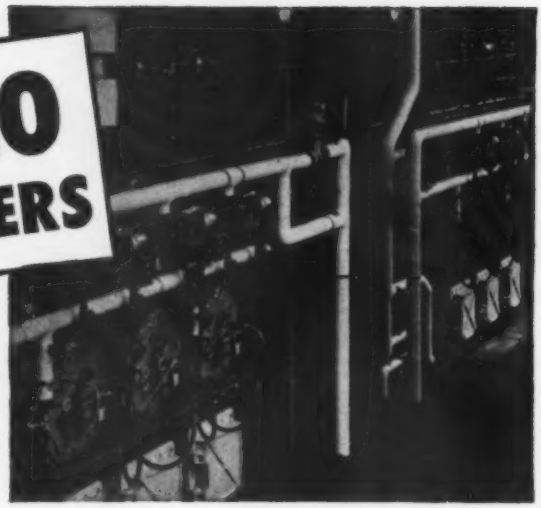
Rockland, Massachusetts

TRiangle 8-5340

For more data circle 552 on Post Card

ENCO BURNERS

FOR
OIL, GAS
OR TAR



Steam or mechanical atomizing...1 to 1000 gallons per hour

Designed for operation with either gas, oil or both with natural or forced draft. They can be depended on for maximum combustion efficiency.

ENCO Interchangeable Oil-Burners can be changed instantly to operate by either steam or mechanical pressure atomizing over a wide capacity range.

ENCO Oil Atomizers are applied to various types of standard pulverized-coal and gas-burner units cold starting or for full load operation when coal or gas is not available, or when oil is the more economical fuel.

Send for Bulletin OB-53 describing ENCO Gas and Oil Burners, also complete Pumping and Heating Units.

THE ENGINEER COMPANY, 75 West Street, New York 6, N. Y.

For more data circle 553 on Post Card

LOOKING FOR A

LOW-COST POWER PACKAGE?

If you are, then seek no more. Here's your opportunity to acquire the generating equipment you need at great savings. The recent conversion of a large downtown Chicago office building to Commonwealth Edison AC has made this like-new equipment obsolete. A systematic program of maintenance since installation has kept these units in excellent operating condition. We invite your inquiries and inspection of the following equipment:

1 DELAVAL TURBINE—Serial No. 255240, A 4000 rpm unit, direct-connected through a 890 hp, 4000-1200 rpm reduction gear to an Electric Machinery Co. 625 kva, 500 kw, 1200 rpm, 240v, 60 cycle, 3-phase synchronous generator, Serial No. 103052. Steam: 400 psig, 625°F; inlet; 150 psig B. P. Includes control board and synchroscope. Equipment was installed new in 1951.

1 SKINNER UNAFLOW ENGINE—Serial No. 11430. Direct-connected to a Crocker-Wheeler, 600 kw, 150 rpm, 250v, 2400 amp, 3-wire DC generator. Steam: 150 psig sat.; inlet, 5 psig B. P. Equipment installed new in 1939.

1 WESTINGHOUSE TYPE 5050 E 12 300KW MG SET—DC motor rated at 1200 rpm, 240v, 1250 amp; and Westinghouse 300kw, 208v, 1040 amp, 3-phase, 60-cycle, 1200 rpm AC generator. Equipment installed used in 1951.

1 ELECTRIC PRODUCTS CO. MG SET—Consisting of a 300kw, 250v, 1200 rpm DC motor Type L8571, Serial No. 67279 and a Type L8556, 300 kw, 208v, 60-cycle, 3-phase, 1200 rpm AC generator Serial No. 67278. Equipment installed new in 1951.

MG Sets offered complete with DC and AC control boards.

OTIS BUILDING
10 SOUTH LA SALLE STREET
FRANKLIN 2-4716 • CHICAGO 3, ILLINOIS

heat applications. It is reported well suited for use in arid regions, since waste heat from the energy conversion system can be rejected to the air.

25—Shallow contact blocks for oil-tight push buttons

Single circuit, shallow contact blocks for use with company's heavy duty, oil-tight push buttons are available from General Electric Co. The new unit eliminates costs of unused circuits in oil-tight push buttons, since only required circuits need be purchased. Sepa-

rate normally-open and normally-closed contact blocks may be mounted in any combination — up to eight — with a standard operator. (Previous limitations were four normally open and four normally-closed blocks.) The new block is nearly an inch shorter than conventional types. Each block added takes up only an additional 29/32 in. Four blocks (four separate circuits) are no deeper behind the panel than a conventional two-circuit block. Publication GEA-7320 gives details.

26—Sealant for repair of transformer oil leaks

Oyltite-Stik is offered by Westinghouse Electric Corp. for emergency sealing of leaks through cracks or pinholes in welds or joints of oil-immersed transformers. It can repair many such leaks while the

transformer is still in service, states manufacturer; it is not affected by temperature changes and remains plastic, expanding and contracting with the part repaired. Similar to a stiff putty, the dark gray sealant comes in sticks, about 4 in. long to rub into leak.

27—Strainers feature heavier construction, lower prices

McAlear Mfg. Co. announces Y strainers and a block steel angle strainer, heavier in design than comparable previous models, yet lower in cost. The Y strainers, No. 530 and 530-G are for steam, water, air, oil or gas, and designed

DESIGNED FOR STEAM TURBINE TESTING

TYPE WG DEAD WEIGHT PRESSURE GAGE

Please request data sheet 593

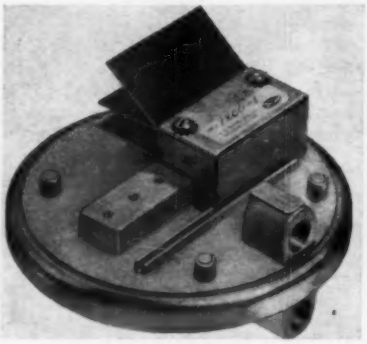
MANSFIELD & GREEN INC.
1051 POWER AVE.
CLEVELAND 14, OHIO

For more data circle 555 on Post Card

to protect traps, regulators, meters and other equipment from dirt, scale, pipe cuttings etc. They come in sizes of ¼ through 3 in. in semi-steel; ¾ through 2 in. in ductile iron or cast steel; 1½ through 2 in. in bronze or stainless steel. Stainless steel screens in a choice of four perforation sizes are standard. The block steel angle strainer, No. 532, is for service to 1500 psig at 850 F, cold pressures to 3500 psi-wog in carbon steel, and higher pressure-temperature use with the chrome moly steel series. Furnished in connecting pipe sizes ½ to 3 in., it is suggested for continuous (surface) blowdown assemblies, high pressure and temperature service. Bulletin 171 gives details.

28—Differential pressure switch features sensitivity, compactness

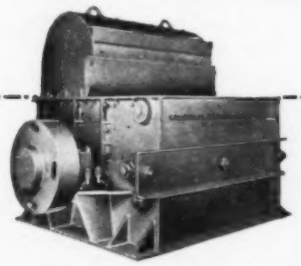
No. 1800 Series Differential Pressure Switch, available from F. W. Dwyer Mfg. Co., is described as a low cost compact (4-in. diam) unit of excellent sensitivity, operating from differential pressures as low as 0.15 in. water with ranges up to 80 in. water. It is designed to hold a set point through various total



pressures and can be operated from plus, minus or differential pressures in any position. Manufacturer says it can be applied almost universally for low pressure sensing and control, such as in cooling coil defrost control, dust collection systems, air filters, air curtain systems. Having few moving parts, the switch is said to be virtually unaffected by severe vibration conditions, even near actuation point. Various arrangements are available from a basic unit with only operating arm protection to switches with weather boot, etc.

This GRUENDLER CRUSHER handles

600 TONS OF COAL PER HOUR WITH EASE!



This is one of a complete line of Gruendler machines for crushing and conditioning coal for cyclone burning. Specified by many consulting engineers because:

Lower original cost
Lower maintenance
Top performance and production

GRUENDLER CRUSHERS ARE BEST

Write for Bulletin 154

GRUENDLER CRUSHER & PULVERIZER CO.
2915 N. Market • St. Louis 6, Mo.

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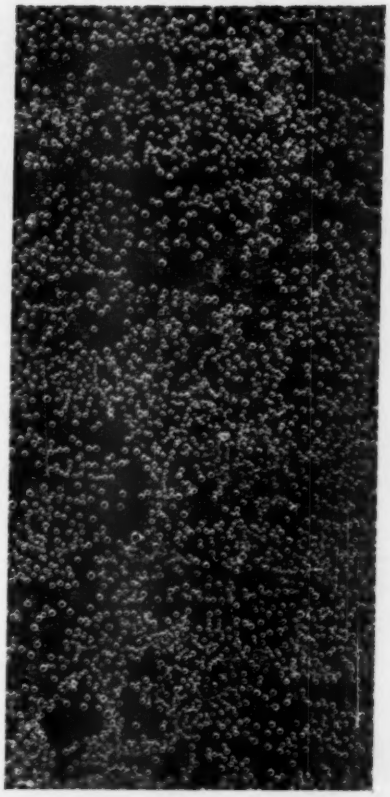
CLASSIFIED ADVERTISING

For Sale

IMMEDIATE DELIVERY

York "Turbopak" open-drive centrifugal water chilling system. Model L95-28B-38A. 300 H.P., 4800V, 3 phase, 60 cycle, 0.8 L.P.F. synchronous motor drive with direct connected exciter. Full voltage starter. Electronic control panel. 361 ton capacity with 855 GPM CH.W at 45° and 1080 GPM condenser water at 80°. 10° water temperature rise. This equipment has never been in service.

Columbia Broadcasting System, 7800 Beverly Boulevard, Los Angeles, California, OLive 12345. ATTN: Mr. F. V. Larkin.



DEOXY-SOL REDUCES OXIDES

in boiler feed water
yet
adds no solids

– and that may be a good reason to select DEOXY-SOL for treatment of your boiler water. But it provides other advantages also.

DEOXY-SOL is a high efficiency oxygen scavenger, since it is a solution of hydrazine. And it raises the pH, supplementing any amine treatment.

Stocks in Newark, N. J., Chicago, Ill., Los Angeles, Calif.

Write for informative Bulletin BW.

Fairmount
CHEMICAL CO., INC.
136 Liberty Street New York 6, N. Y.

For more data circle 557 on Post Card

THE LONERGAN LINE

A. J. Schmidt
Chief Engineer

SIZING SAFETY VALVES

by A. J. Schmidt, Chief Engineer

Selection of a safety or relief valve should be made on the basis of the capacity requirements of the application, rather than on pipe size alone. Using pipe size as the sole basis may result in a valve with far greater capacity than required and the valve may chatter on the installation due to a "starved" condition. On the other hand, pipe size selection may provide a valve with too little capacity, which will not give adequate over-pressure protection.

It is much better to select a safety or relief valve for the actual capacity requirements of the system. This will reduce the initial cost and will keep operating costs down because proper operation and protection will be obtained.

Lonergan safety and relief valves provide additional cost advantages due to the high capacities provided for any given pipe size. Thus, you can specify the smallest possible valve to meet your capacity requirements. Lonergan V, W, 11-W, and 41-W series safety valves also provide all the advantages of top guided, nozzle valve construction and two-ring positive control as embodied in Lonergan Patent No. 2414794.

Complete descriptions of Lonergan safety and relief valves for all applications are in catalogs 900-V and 1000-V. Write for your copy to the address shown below.

Alvin J. Schmidt

Lonergan

J. E. LONERGAN CO., 207 RACE STREET
PHILADELPHIA 6, PA. SINCE 1872

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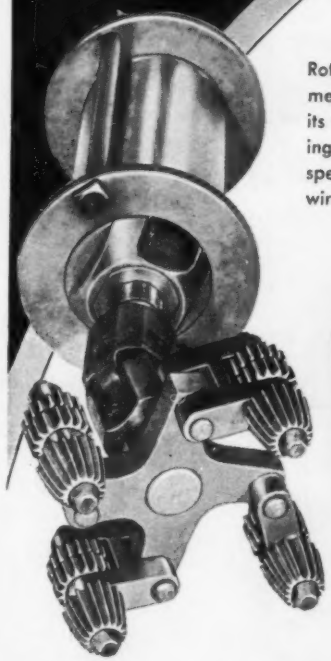
Cleans TUBES and PIPES

ANY SIZE

from ½" to 12" I.D.

STRAIGHT or CURVED



Roto engineers are constantly designing new equipment to meet new conditions and applications for its tube cleaners. If you have a pipe or tube cleaning problem, we will be pleased to place our long specialized experience at your disposal. Write, wire or

Phone HUmboldt 3-0570

Illustrated are a few of the many types and sizes of Rotojet Tube Cleaners driven by air, steam or water. We analyze each application before recommending equipment that best meets the requirement.

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Tube Cleaner Specialists Since 1910

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NEW 8 blade

tubeaxial fans

high speed - high efficiency

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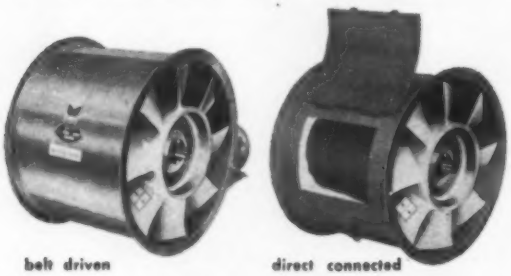

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CERTIFIED PERFORMANCE

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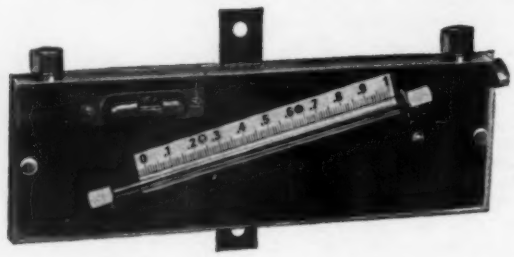
YOU GET *accuracy with economy in this new Ellison "AFS" Air Filter Gage*



The new Ellison Series AFS Air Filter Gages show when air filters have become clogged and need changing. Easy to install. Easy to read. Clear plastic snap-on cover keeps scale clean. A really accurate, well-made instrument at a surprisingly low cost. Eliminate guesswork and cut costs—no need to change filters until gage so indicates. The "AFS" is a new addition to the most complete line of air filter gages—the Ellison Line. A gage to fit every budget! Send for Bulletin 214$_3$C.

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550 W. MONROE STREET, CHICAGO 6, ILLINOIS

Draft Gages, Bell and Diafram—Inclined Draft Gages—Portable Inclined Tube Gages—Vertical Tube Gages, Oil, Heavy Liquid, Mercury, Single and Multi-tube—U-gages Stationary and Portable—Air Filter Gages, Complete Line—Pitot Tubes—U-Path Steam Calorimeters—Portable Gas Analyzers, Orsat Type—Alarm Systems—Orifice Flanges and Plates—Flow Tube Meters—Condensate Traps.

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Sterlco® THERMOTROL

ACCURATE INDIVIDUAL ROOM TEMPERATURE CONTROL... FOR STEAM OR HOT WATER SYSTEMS

Controls each unit of radiation independently . . . provides heat only when temperature in immediate area falls below setting. Prevents overheating and fuel waste . . . corrects unbalanced systems. Self-contained . . . needs no external power supply or control . . . eliminates thermostats and zone valves. Installs like a radiator valve. Not recommended for 1 pipe steam systems.

Write for Bulletin 501

Leaders in temperature controls since 1916

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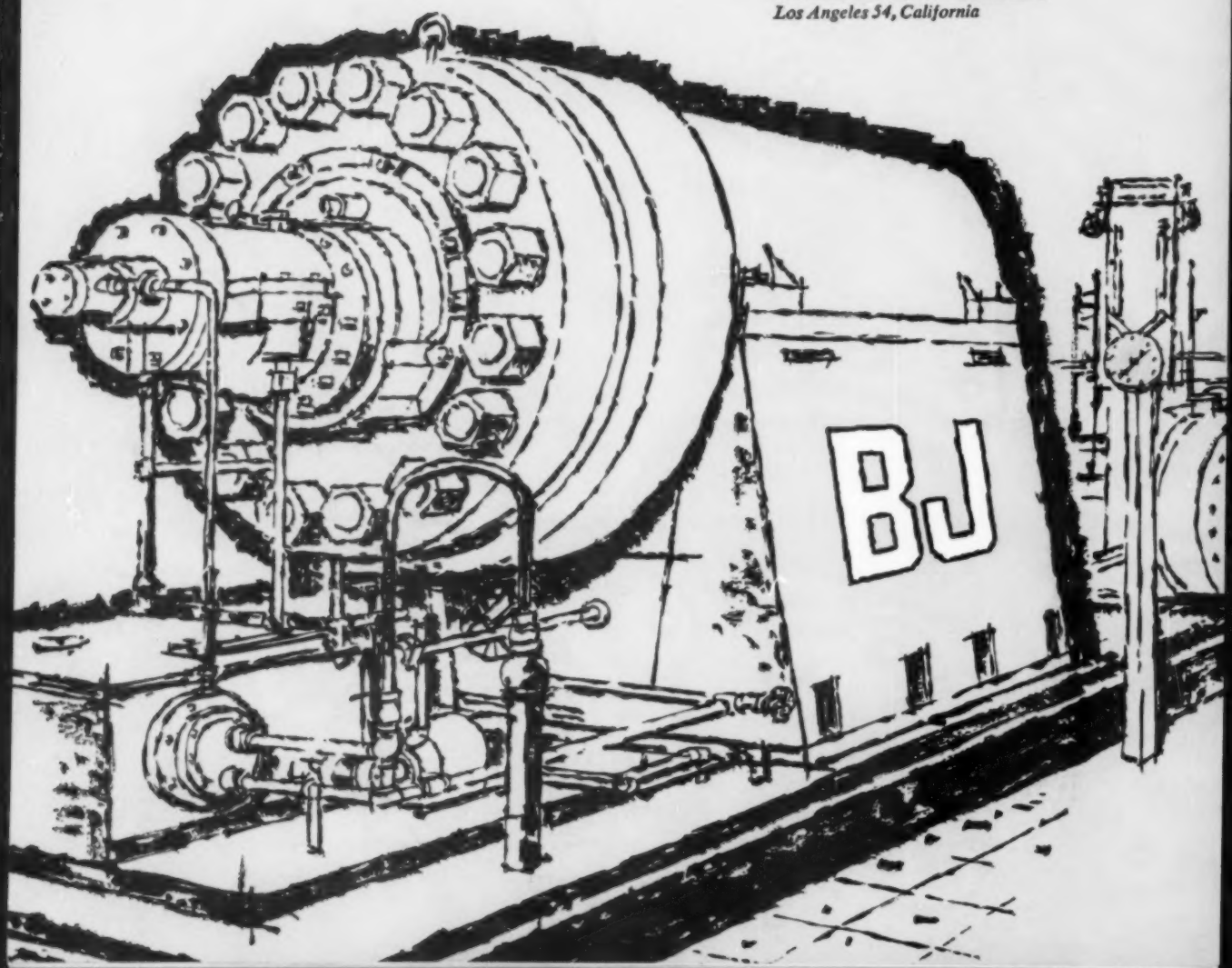
Reliability is the only real "bargain" you can afford in a boiler feed pump. Reliability that comes from the basic quality built into a pump, and the reliability that assures long, continuous performance under all conditions.

At BJ, quality is a full time job. Trained personnel with long experience in building quality pumps are combined with the latest facilities, equipment and special techniques. The result is a line of boiler feed pumps to meet the higher speeds and temperatures, greater capacities and higher pressures required of modern boiler feed service.

BJ Quality does cost less in the long run!

Southern California Edison Company *orders two 12,000 HP Double Case Pumps for their new Alamitos Stations No. 3 and 4. Thirteen BJ Boiler Feed Pumps are already in service in another So. California Edison Station.*

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